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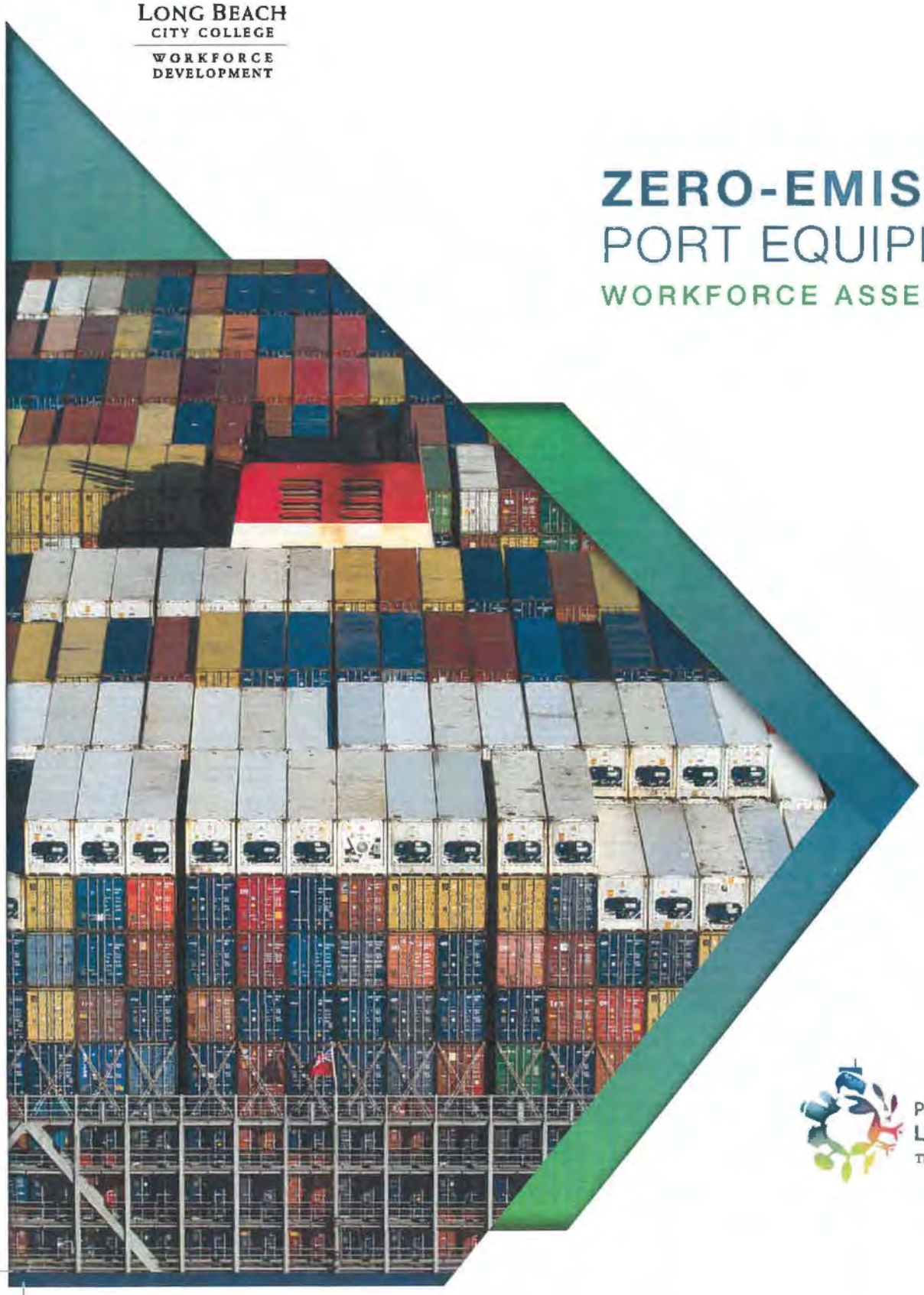
On Zero-Emission Port Equipment Workforce Assessment

Additional submitted attachment is included below.

LONG BEACH
CITY COLLEGE
WORKFORCE
DEVELOPMENT



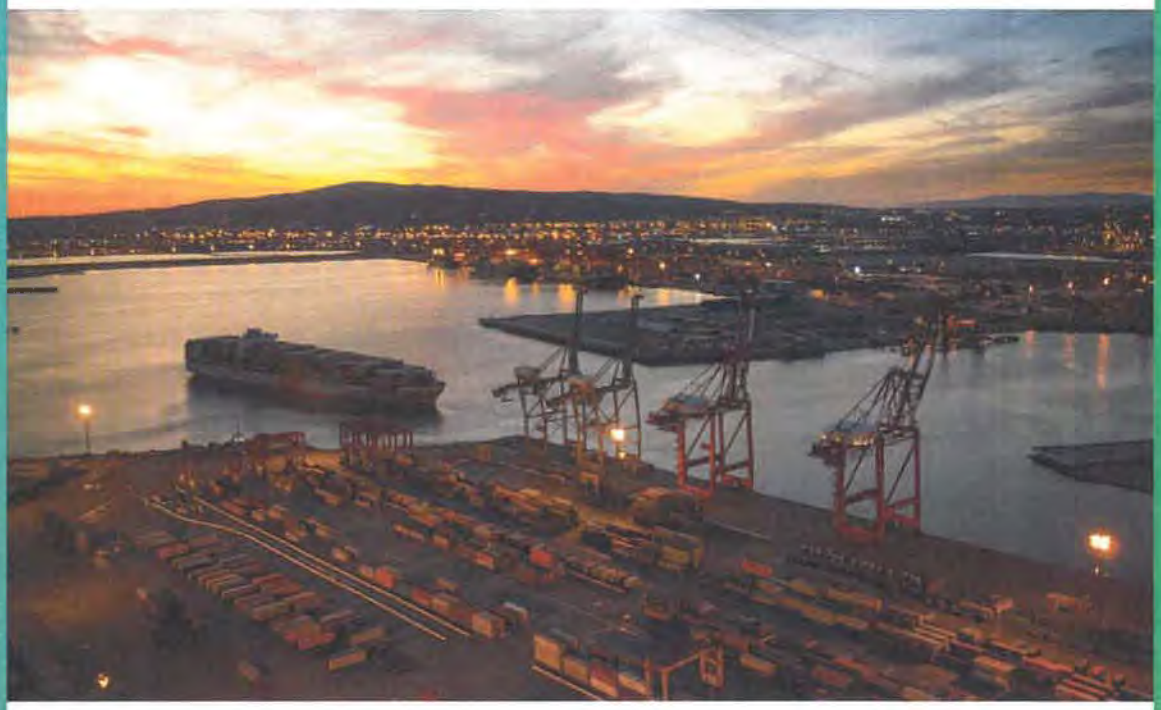
ZERO-EMISSION
PORT EQUIPMENT
WORKFORCE ASSESSMENT

Port of
LONG BEACH
The Green Port

ACKNOWLEDGEMENTS

LONG BEACH CITY COLLEGE would like to thank our project partners, stakeholders, and educational institutions for their support in this project. Thank you to the California Energy Commission and the Port of Long Beach for the funding and the opportunity to examine the potential changes to the workforce that electrification at the Port may bring. We also are eppreciative to the stakeholders in this project who gave their time to attend meetings and participate in informational interviews: IBEW Local 11, International Transportation Service (ITS), Long Beach Container Terminal (LBCT), SSA Marine Terminal, and Total Transportation Services Inc (TTSI). The vendors involved in this project also contributed to this report, including BYD, US Hybrid, and Cavotec. We also appreciate the time provided to us by the Deputy Sector Navigators for Energy, and for Advanced Transportetion, who validated our approach to this work and made recommendations for further exploration.

Finally, our sincerest gratitude to staff at Long Beach Unified School District, and the faculty at the 23 regional community colleges who filled out surveys, participated in informational interviews about their programs, and shared their perspective on the future workforce needs.



ZERO-EMISSION PORT EQUIPMENT WORKFORCE ASSESSMENT
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01

EXECUTIVE SUMMARY

Long Beach City College was engaged by the Port of Long Beach to perform a workforce gap analysis related to their demonstration of 25 new or converted zero emission vehicles. In addition to the gap analysis, we have included project related equipment adoption projections which may drive workforce needs, as well as estimates on the creation of new jobs. This effort, Port of Long Beach Zero-Emissions Terminal Equipment Transition Project, is funded by the California Energy Commission.

EQUIPMENT ADOPTION PROJECTIONS

In projecting the workforce demand needed to support the transition to zero emissions technology, as well as the specific skills needed for roles, equipment adoption rates were estimated and this report includes reflections on the range of issues driving the speed of adoption, especially by the terminal operators. There are several inhibiting factors that may impact the pace of adoption thereby impacting the labor needs, mainly the cost of infrastructure and immature technology, the cost of batteries, technical factors including the speed of charge, and the maturity of the vehicles.

POTENTIAL JOB GROWTH

In projecting adoption rates, we were able to also project potential job creation. We considered three categories related to port electrification: vendor jobs (pilot vendors were all local) in retrofitting or manufacturing, operator jobs in maintenance, and infrastructure jobs for installation of charging or electric power service. We found that most of the workforce needs for port electrification will be workers in the infrastructure area, vendor needs supporting Port equipment will also absorb new workers with new skills, and maintenance will likely be a retraining mission of existing workforce.

COMPETENCIES

Through interviews with original equipment manufacturers (OEMs), terminal operators, labor representatives, and subject matter experts we identified the needed skills and competencies for entry level and incumbent workers. There are 29 key skills within eight broad areas including Battery Safety, Battery Theory, Charging Components, Electrical Connections in Corrosive Environments, Equipment Maintenance, General Electrical, Mechanical Aptitude, and Zero Emission Technology. Both OEMs and terminal operetors reported that servicing these electric vehicles is less labor intensive than diesel and believed that existing mechanics should be able to service these new vehicles with current skills and minimal training.

COMMUNITY COLLEGE PROGRAMS

Through interviews, surveys and the review of course details and program offerings in 23 colleges, we have been able to identify four regional colleges that have both advanced transportation programs and electrical programs as well as already integrated zero emissions technology concepts into their curriculum. In addition, there are 13 that have advanced transportation programs with zero emissions concepts integrated. These colleges are geographically diverse, including Los Angeles and Orange Counties, which provide the larger community greater access to their training and education programs.

In addition, several community colleges in the region have not-for-credit offerings for incumbent workers in the area of advanced transportation. These classes are fee-based and operate on full cost-recovery, rather than being priced on a per unit basis. Employers often pay training fees for their workers to attend the trainings, or they take advantage (if they qualify) for funding from the State to subsidize training fees. Regionally, Long Beach City, Cerritos, and LA Trade Tech Colleges offer not-for-credit training in the area of alternative fuels.

LONG BEACH UNIFIED SCHOOL DISTRICT EDUCATIONAL PATHWAYS

Nationally there is a movement to transition high schools into industry-focused academies which are smaller in scale within comprehensive high schools and have robust industry engagement and a career focus. This approach is called Linked Learning and the programs are referred to as pathways. Long Beach is already ahead of many cities across the nation with the full implementation of linked learning and we have identified seven high schools with pathweys related to the Port's zero emission work. In fact there are nine middle and high schools that have integrated curriculum on electric vehicle technology. There is a good geogrephic distribution of programs throughout the city offering access to students throughout Long Beach.

INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS (IBEW) Apprenticeship and Training Programs

The IBEW's Local 11 union branch, which covers the greater Los Angeles area, currently represents 11,700 members and this year they accepted 600 new apprentices. They continue to train new apprentices and retrain and upskill existing members to work in the growing field of zero emissions technology. In addition to the treditional apprenticeship path, IBEW offers the Electric Vehicle Infrastructure Training Program (EVITP) which is the highest standard in training and certification for the installation of electric vehicle infrastructure.

RECOMMENDATIONS

The bulk of the work of educating and training the future and incumbent workforce will fall to community colleges and to our labor partners. Community colleges work with a unique set of challenges, and a lack of flexible funding is the greatest. Colleges have the talent in their faculty, the tools and equipment in their labs, and a captive and eager audience in their students. What we lack however, is funding to be able to quickly develop training in response to changing technologies and industries' demands. With additional flexible funding for short term incumbent worker training, we are not only able to meet the immediate needs of local industry, but also pilot new curriculum that can then be integrated into our existing credit bearing certificates and degrees updating those programs to better prepare the future workforce.

02

PROJECT BACKGROUND

In support of a zero emissions future, the Port of Long Beach (Port), California Energy Commission (CEC), Long Beach City College (LBCC), the International Brotherhood of Electrical Workers (IBEW) Local 11, and industry, partnered to assess needed skills of current and future workers, identify skills gaps, evaluate regional educational and training programs, and make recommendations to support the regional workforce.

The Port, an award winning Green Port, has been piloting zero emission vehicles and technology to achieve zero-emission terminal equipment by 2030 and zero-emission trucks by 2035. Through the CEC grant "Zero-Emissions Terminal Equipment Transition Project" the Port is demonstrating 25 new or converted vehicles. Vendors include: Cavotec providing electric rubber tire gantries (eRTGs), BYD providing battery electric vehicle (BEV) yard haulers, and US Hybrid converting LNG trucks to hybrid electric. These 25 pieces of electrified cargo handling vehicles will be deployed at the terminal operators, International Transportation Service, Long Beach Container Terminal, and SSA Marine as well as at TTSI, a logistics company.

Outlined in this report, the reader will find data on the adoption projections, new job creation, new skills and competencies needed, existing regional educational and training programs at the community college level and locally in the Long Beach Unified School District (LBUSD), training offered through the IBEW, and lastly recommendations for all stakeholders including funding partners on how best we can prepare a zero emissions workforce. Long Beach City, Cerritos, and LA Trade Tech Colleges offer not-for-credit training in the area of alternative fuels.

03

ZERO EQUIPMENT VEHICLE ADOPTION PROJECTION ANALYSIS

Port equipment electrification has been identified by the Port of Long Beach (and Port of Los Angeles) as a key catalyst in reaching their shared goals of zero emissions by 2030 as part of their 2017 Clean Air Action Plan Update. In interviews with stakeholders on zero emissions equipment adoption and its impact on workforce, we discovered common considerations for scaling this work and have collected and included those data points in this report as well as projected adoption scenarios based on these interviews which can impact future workforce demand.

Considerations included the affordability of infrastructure, expense of electric equipment, and upfront capital cost in a competitive goods movement environment in addition to the availability of reliable equipment, work rules for port workers, and work interruptions around the transition to electric power. Salient regulatory influencers include public grants and incentives for heavy-duty vehicles as well as internal Port goals and plans. An additional driver for adoption is the support of Southern California Edison in building up the electric power infrastructure needed to supply the vehicles with necessary energy.

3.1 REVIEW OF RELATED RESEARCH

To better inform our adoption projections, we reviewed publicly available reports and studies, especially on the economic drivers of adoption of electric vehicles in a port setting. The goal of this phase was to identify issues of concern and opportunities for port electrification. Unfortunately, much of the available information is older, deals with hybrids, and/or focuses on light-duty fleets. We also reviewed other major ports, but none had a formal electrification program of the scope of the Ports of Long Beach and Los Angeles. The Port of Busan has a quite small demonstration area, and the Port of Rotterdam has an environmental plan in place, but neither specifically concentrates on energy and equipment electrification.

3.2 STAKEHOLDER INTERVIEWS

Interviews with 12 stakeholders, including terminal operators, technology vendors, port officials and unions were conducted over a three-month period to understand both adoption intentions and the ensuing workforce related needs. We wanted to look at both the work that would be done in the future, and who would be doing it. In addition, we were interested in the location and employment of the workers to identify the best ways of training existing workers for new skills and treining entry level workers in new work categories. For example, most of the infrastructure upgrading tasks are handled by a few contractors, but the work for the most part is performed by IBEW members, making the union a natural fit for training. To validate our findings, we held two workshops with grant stakeholders in which we presented our qualitative findings and asked for comment and clarification as we worked to create a quantitative model for technology adoption and associated workforce needs. The feedback received was incorporated in our projections for both.

Another group of workers identified in the interviews were those currently providing vehicle maintenance. There was some discussion over whether the adoption of the new zero emission vehicle (ZEV) equipment would require additional training for existing maintenance workers or if the maintenance itself would be supplied by the vendors through service contracts. While offsite maintenance might introduce some delays and lack of control of timeline for critical equipment, it is also a less risky choice, as the vendors have the knowhow to support the vehicles and are less likely to make mistakes on unfamiliar equipment. In addition, they would presumably have full documentation of design and schematics that vendors might not want to release to the terminal operators. Most operators were motivated by the desire to limit the downtime a maintenance model would present. The model itself, onsite or offsite, or provided by the vendor or existing staff, was not the priority but rather the model that provided the least impact to their operations. That being said, most operators felt existing workers could, with minimal safety training, provide the maintenance needed for daily operations assuming vendors could provide the training and needed schematics and manuals.

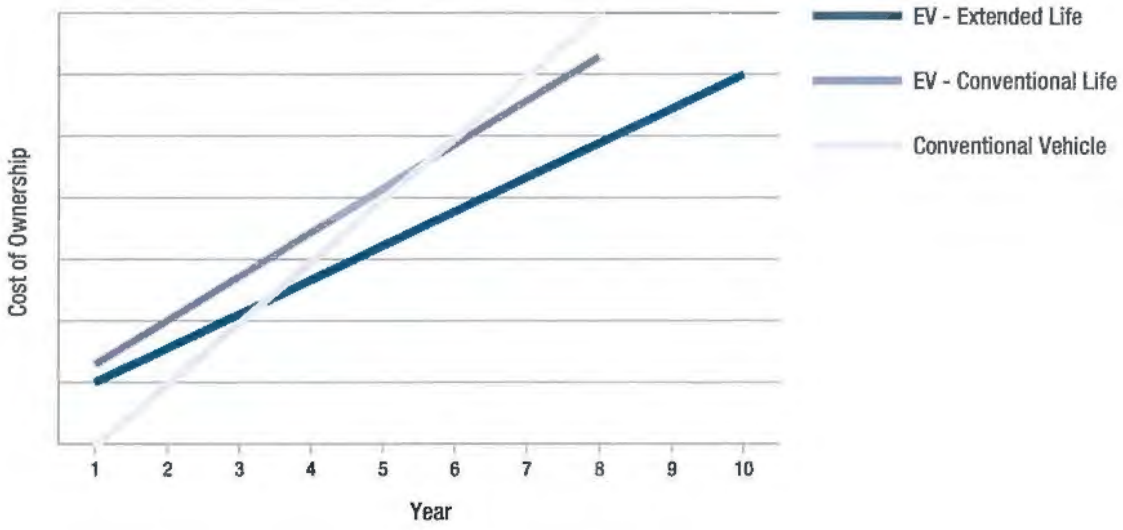
Finally, given that the vendors in this pilot were local to the Port, there is a tremendous opportunity for growth in manufacturing and assembly jobs as local ZEV adoption increases. Most vendors seemed to prefer local manufacturing to overseas. Any future workforce analysis should also include new workers and the skills needed to produce the equipment as there was clear indication there would be growth in this area.

3.3 ECONOMIC DRIVERS FOR ADOPTION

Fuel cost and predictability are important drivers for adoption of electric vehicles in the Port setting. Fuel cost is a major operating expense for terminal operators, and the unpredictability of fuel prices can drive operators to hedge with futures and other risk mitigation strategies (Mike Antich, "Proven Strategies to Mitigate Rising Fuel Costs," 2012). Electricity is generally regulated (for example, the California Public Utilities Commission approves pricing changes for Southern California Edison, the utility providing power to the Port of Long Beach) and changes in price are more measured than the relatively volatile market for fossil fuels. In general, electric power is cheaper than fossil fuel power; fleet adoption studies generally find the cost is between 30 percent and 50 percent cheaper for electric power versus internal combustion powered vehicles (Edison Electric Institute, "Transportation Electrification," 2014). A second economic driver is the maintenance of electric powered equipment (Applied Energy, "Total Cost of Ownership and Market Share for Hybrid and Electric Vehicles in the UK, US and Japan," 2017). Typically, electric vehicles need less repair or regularly scheduled maintenance than internal combustion engine (ICE) based vehicles. This advantage is currently greater in light-duty vehicles where the technology is more meture and engineered for reliability. In the heavy-duty segment, volumes of production are lower, and while there may be less repair incidents, they may be more costly.

Additional factors currently impacting the cost of maintenance include poorly documented vehicle design and lack of diagnostic equipment and trained repair workforce (NAVFAC, "Demonstration of Heavy Hybrid Diesel Fleet Vehicles," 2016). For this reason, some terminal operators expressed skepticism about the benefit expected from reduced cost of electric vehicle maintenance. Indeed in one of the few studies of heavy-duty vehicle maintenance costs of fleet electrification, in this case hybrids, maintenance savings were a significant contributor to the economics of adoption (NAVFAC, "Demonstration of Heavy Hybrid Diesel Fleet Vehicles," 2016). These considerations are important for workforce policies as they impact the rate of adoption as well as workforce development needs as vehicle operators choose between onsite in-house maintenance and vendor provided maintenance strategies. In general, Total Cost of Ownership (TCO) is an important factor in adoption, and electric fleets provide attractive economic rationalization based on both reduced fuel costs and maintenance. The graph below from the Edison Electric Institute shows TCO, although the data was not specifically from a port fleet. This shows that electric vehicles (EV) have a higher up front cost but for those with longer lasting batteries, mainly more recent models, the cost of ownership is cheaper after four years of service, and the advantage grows as the replacement cycle is longer, in our case around 10 years according to terminal operators interviewed.

ESTIMATED TOTAL COST OF OWNERSHIP



3.4 ECONOMIC BARRIERS TO ADOPTION

Typically, adoption of new technology starts slowly, then accelerates in the mainstream, and finally tapers off at the end, describing an S when plotted on a chart. It is the beginning of this curve that is cited in Geoffrey Moore's classic book *Crossing the Chasm*, from early adopters to mainstream, as a key goal for innovators. We anticipate a slower start for the transition to electric fleets than the typical S curve of innovation diffusion.

There are several inhibiting factors that may impact the pace of adoption thereby impacting the labor needs, mainly the cost of infrestructure and immature technology (ICCT, "Transitioning to Zero-Emission Heavy-Duty Freight Vehicles," 2017). While charging of light-duty vehicles is quite standardized with the widely available J1772 home charger and combo direct current fast charging (DCFC), port equipment has much higher power needs, and there is no standardized charging equipment available for all equipment. The ISO 15118 promises a much better match to equipment needs, as it can handle higher power loads and support Vehicle to Grid (V2G), useful in integrating power infrastructure, but is still a few years away.

A second contributing factor is the cost of batteries, both in the vehicles and potentially in the charging infrastructure if storage is used tó smooth power loads. While lithium batteries heve come down in price dramatically over the past few years, the cost is not yet low enough to provide parity with Internal Combustion Engines (ICE) vehicles. (NREL, "Batter Technologies for Heavy Duty Electric Vehicles," 2015).

There are several technical factors impacting adoption as well, including speed of charge (especially important for the duty cycle at ports where multiple shifts use the same equipment), durability of the battery, and ability to fully charge and discharge. These technical and economic problems with batteries are likely to be addressed in the next three years, making early adopters reluctant to invest in equipment with a 12-year life span that may be outdated in four years. Thus, if not prompted by grant or incentive stimuli, many terminal operators would take a wait and see attitude.

Finally, the maturity of the vehicles and the engineering encompassed, as well as small scale production of heavy-duty vehicles, mekes the per unit cost higher. As volumes increase end supply chain economics impact production costs, purchase prices should go down as should maintenance and charging infrastructure costs. Specifically yard hauler costs should go down as many of the components are also used in other heavy-duty (Class 8) vehicles as well, enabling supply chain economics of scale. In addition, electric rubber tire gantries (eRTGs) will likely be cheaper in the future as battery price and functionality permits mobile operation using charging end storage of power instead of the current tethered mode of operation (a power cable on winders constantly supplies power) which has higher infrastructure costs.

We believe these factors will increase the pace of electric equipment adoption and deployment in the year just before the 2030 zero emissions target date. A key factor is that this equipment has a 12-year replacement cycle, so on a normal cycle any replacement should be electric starting in 2018 to heve a completely electric fleet by 2030.

04

ZEV ADOPTION PROJECTIONS

Data collected in the interviews, as well as the feedback sessions combined that with the research on economic and regulatory drivers were used to generate projections for each class of equipment in the pilot deployment. We generated an adoption curve based on interview responses, our analysis of financial drivers, technology development and cost projections for each type of electric vehicles.

Consideration of several diffusion of innovation models for adoption informed our slow starting S curve. This was then used to create the workforce needs by year, as the trigger for workforce need changes is the adoption of the electric vehicles. We ended up looking at the following impacted activities and related skills:

- Equipment Maintenance
- Installing and Retrofitting Infrastructure
- Original Equipment Manufacturer (OEM) Technicians

These projections, as well as some discussion, are presented in the following sections.

4.1 GRANT SUPPORTED VEHICLES

As outlined earlier, the CEC grant supported the purchase and demonstration of 25 new or converted vehicles. Vendors included are: Cavotec converting rubber tire gantries to electric (eRTGs), BYD providing battery electric vehicle (BEV) yard haulers, and US Hybrid converting LNG trucks to hybrid electric. These 25 pieces of electrified cargo handling vehicles will be deployed at the terminal operators, International Transportation Service, Long Beach Container Terminal, and SSA Marine as well as at TTSI, a logistics company. We selected a 12-year period to collect data on participant expectations of electrification, to align with anticipated regulatory action that will be enforced as of 2030. Based on the adoption curve generated and outlined previously, we estimated the manpower and skills associated with the anticipated rate of adoption.

4.2 YARD HAULERS

Yard Haulers are Class 8 off-road vehicles used to move containers around the terminals to a truck or rail loading location for distribution to warehouses and other logistic centers. As such they represent an important type of port equipment with good electrification potential. Given that much of the core technology is common to other Class 8 vehicles, this field is expected to leverage truck electrification scaling over the next decade and take advantage of core development in both storage (lithium ion batteries) and charging infrastructure (especially fast charge).

ADOPTION OF ELECTRIC YARD HAULERS														
YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
BEV YARD HAULER	9	0	33	41	41	50	57	62	82	98	107	115	132	830

For the above table and the adoption projections, we did not include the pilot funded by the CEC grant, as it may skew true market-based decisions, and operators indicated they would not have purchased them absent financial incentives. The grant, however, is significant in later adoption as identifying both suitability to port tasks as well as operating costs could be evaluated. As discussed previously the adoption curve starts slowly and escalates at the end of the period, reflecting both Port ZEV planning and better costs for the equipment and charging. We gave a fairly limited role to hybrids in this projection, as they are likely a transition technology in the event that charging infrastructure solutions are developed and installed economically. We expect maintenance costs to be higher during the transition (supporting both ICE and electric drive systems). The major advantages of having both ICE and BEV vehicles is to avoid demand charges and electrical infrastructure installations due to the usage cycle of two shifts with less BEVs (which require expensive fast charging for BEV vehicles). Microgrids with battery energy storage systems can address the fast charge issue as grid tied storage costs drop.

4.3 ELECTRIC RTGS

RTG equipment is used to move containers from stacks offloaded from ships to deployment areas for distribution. Key factors for these units are twofold. Firstly, the weight is high, requiring reinforced concrete in areas of operation, which in turn requires local power sources. Secondly, the weight of the container is counterbalanced by a dead weight similar to an elevator counterweight. This dead weight could be used for a large battery with slight design modifications. For the pilot, standard RTG units were modified with an electric cable for power, which was stored on a reel for safety, and the vehicles could not operate in an untethered mode.

ADOPTION OF ELECTRIC RUBBER TIRE GANTRIES														
YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
eRTG	9	0	2	3	3	4	4	5	6	7	8	9	10	71

While the number of eRTG units is low, the impact on the Port is significant as each unit uses a large amount of power. A range of other related equipment with similar functionality, such as cranes and rail mounted gantries, could benefit from the same type of retrofit, but were not covered by the pilot. Again the adoption curve is back weighted, for the same cost and regulatory reasons as yard haulers, with the reduction in cost of batteries potentially providing a superior solution in the future.

4.4 PLUG IN HYBRID ELECTRIC CLASS 8 TRUCKS

We only counted trucks operated by TTSI in this category, so while their fleet was 71 vehicles at the time of the interviews they may be taken as representation of several thousands of Class 8 vehicles serving the Port. TTSI is based off-port and the vehicles are road class so they often do round trips of 100 miles to the warehouses stretching into the Inland Empire. As such, the charging infrastructure is quite important, as is BEV range. TTSI had ambitious microgrid plans to address this, as well as a desire to evaluate fuel cell vehicles, when cost ready. This made them likely an early adopter of ZEV technologies, but potentially also a model for other trucking and logistics firms. In this pilot, US Hybrid will be converting four LNG-fueled Class 8 trucks to plug in hybrid electric trucks (PHET). This pilot will permit them to explore electrification in advance of charging infrastructure and fuel cells adoption while meeting current range requirements.

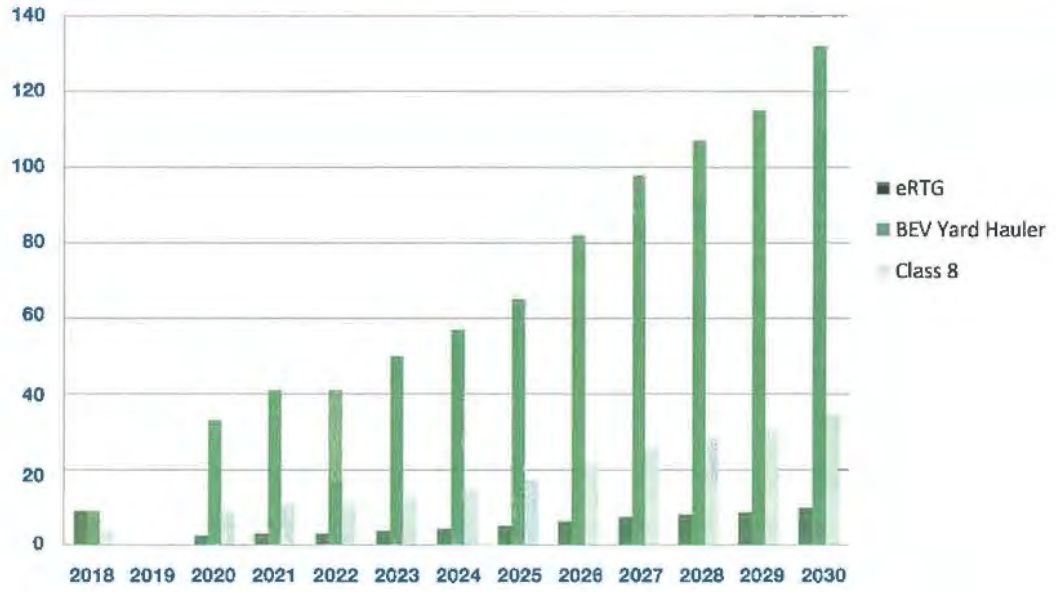
ADOPTION OF PHET CLASS 8 TRUCKS														
YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
CLASS 8 TRUCKS	4	0	9	11	11	13	15	17	22	26	28	30	35	71

They expressed a desire to wait for known manufacturers such as Peterbilt and Mack to come out with BEV vehicles, as they understand the trucking industry and will likely be around to support the vehicles, unlike a more risky start up. Thus in spite of their interest in new technologies their adoption is likely to be back loaded around the 2030 ZEV target date.

4.5 SUMMARY OF ELECTRIFICATION ADOPTION

We consider the eRTGs, Class 8 trucks, and BEV Yard Haulers to be the major categories, with HBEV Trucks as a transition technology. It seems that the HBEV Class 8 vehicles will be replaced by BEVs once practical, and the operator showed little interest in converting the fleet to HBEVs only to change it again in the future. In examining workforce needs, the HBEVs are similar to BEVs with regards to new skills required for maintenance, although local vendor workforce needs are slightly different, per vendor point of view, as they are retrofits of LNG vehicles.

ADOPTION OF ELECTRIC EQUIPMENT



05

ADOPTION IMPACT ON WORKFORCE

The adoption of zero emission cargo handling equipment, as outlined above, is anticipated to be a gradual process that picks up pace with the approach of regulation deadlines. Because of this, the changes in the workforce skills needed to work on cargo handling equipment at the Port will not simply turn over from standard internal combustion engine (ICE) vehicles to zero emission vehicles all at once. Additionally, we discovered through discussions with stakeholders that workforce opportunities and changes would not be limited to the Port complex itself but would instead start with the vendors producing, supplying, and installing the equipment and infrastructure. The following sections outline the opportunities and anticipated rate of change of workforce skills due to electrification efforts at the Port.

5.1 NEW OPPORTUNITIES FOR WORKFORCE GROWTH

We identified three categories of potential jobs related to port electrification: vendor jobs (pilot vendors were all local) in retrofitting or manufacturing, operator jobs in maintenance, and infrastructure jobs for installation of charging or electric power service. The lattermost covers only the equipment used for charging the equipment, as other power upgrades for economic power availability will be covered in a separate microgrid study. For vendor manpower and skills we identified their needs in terms of skills for the pilot production, and estimated their needs should these vendors participate in future port electrification work. These numbers could be lower if operators such as TTSI buy vehicles from non-local manufacturers such as Peterbilt or Mack, but could also be higher if local vendors such as Cavotec leverage their pilot experience in retrofitting RTGs to become eRTGs for export sales to other ports. Most interviewees did not have concrete opinions on these items, taking a "wait and see" approach, so we will use the numbers generated by the pilot for this analysis.

5.2 WORKFORCE NEEDS AND YARD HAULER ADOPTIONS

Maintenance of yard haulers is likely to be handled by the retraining of existing maintenance workers, or potentially by off-port vendors under a support contract. Operators expressed some doubt that standard fleet electrification cost and manpower savings in maintenance would apply exactly to their fleets, noting that the equipment is new and many warranties will still apply. Furthermore, operators are motivated to consider vendor maintenance contracts, at least in the short term; due to the reality that this is unfamiliar equipment, training programs are not in place and would need to be created, and there may not be proper documentation and needed diagnostic equipment. In the less than likely case that they did find reduced manpower needs for BEV fleet maintenance, their strategy would be enhanced training for existing staff and workforce reduction through attrition.

During the period considered, infrastructure jobs will be the largest manpower gainer from Port electrification. The numbers used to estimate these job gains were the result of triangulation: Port estimates, Port contractors who would potentially use IBEW union labor to install the chargers, and other comparable fleet electrification projects for medium and heavy duty BEVs.

Vendor jobs are also counted in this estimate, although with less clarity than other categories, as BYD, the supplier of these vehicles, assembles the vehicles in Palmdale, which is still in state and in region but not proximate. BYD did express interest in providing contract maintenance services, which might be located locally, but wanted to see the operator needs before investing in a facility. In the table below, labor requirements are given in terms of person years, assuming 2,000 hours per year of productive (task-oriented) work.

WORKFORCE NEEDS FOR ELECTRIC YARD HAULERS

YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION	0%	0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
BEV YARD HAULER	9	0	33	41	41	50	57	65	82	98	107	115	132	830
INFRASTRUCTURE (PERSON YEARS)	11	0	35	44	44	52	62	71	88	106	114	123	140	890
VENDOR (PERSON YEARS)	6	0	18	22	22	27	31	35	44	53	59	63	72	454

5.3 WORKFORCE NEEDS AND eRTGS ADOPTIONS

The eRTG workforce needs are for a retrofit of existing RTG products for the Port and are also included in future needs projections. There is an estimated 50 percent reduction in maintenance compared to diesel equipment, with a high probability of the vendor doing contracted maintenance with similarly skilled workers as their onsite production workers.

WORKFORCE NEEDS FOR ELECTRIC RUBBER TIRE GANTRIES														
YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION	0%	0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
eRTG	9	0	2	3	3	4	4	5	6	7	8	9	10	71
INFRASTRUCTURE (PERSON YEARS)	51	0	14	18	18	21	25	28	35	42	46	49	57	405
VENDOR (PERSON YEARS)	13	0	3	4	3	5	6	7	9	10	11	12	14	99

Infrastructure efforts are significant for this equipment as the power needs are high and flexible power sources managed by reels must be installed. If the equipment goes toward battery based power there might be a slight decrease in infrastructure and increase in vendor manpower needs, but the skills will remain similar, and the workforce needs should be similar for vehicle operation of battery powered eRTG with slightly different allocation of roles.

5.4 WORKFORCE NEEDS AND CLASS 8 TRUCK CONVERSIONS

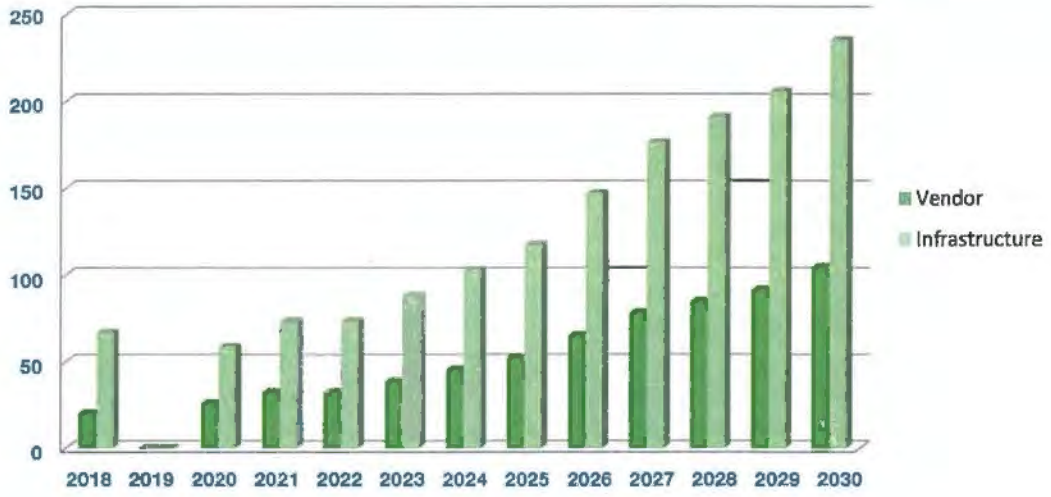
This category is a bit challenging as TTSI indicated that they would likely move from PHET to BEV once the BEV solution is mature. In such a case the infrastructure needs would likely be higher and the vendor needs would be similar in terms of labor and skills required. The only unpredicteble factor would be if the vehicles were producad out of region, which would decrease the vendor labor needs. However, there are a numbar of local companies developing BEV Class 8 solutions that could service port needs as well. We decided to use the existing products to base our projections on, although with the caveat that much uncertainty remains in terms of vendor selection and product specification.

WORKFORCE NEEDS FOR ELECTRIC CLASS 8 TRUCKS														
YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
% ADOPTION	0%	0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
CLASS 8 TRUCKS	4	0	9	11	11	13	15	17	22	26	28	30	35	71
INFRASTRUCTURE (PERSON YEARS)	4	0	10	12	12	14	17	19	24	29	31	33	38	242
VENDOR (PERSON YEARS)	2	0	5	6	6	7	8	10	12	15	16	17	19	123

5.5 SUMMARY OF WORKFORCE NEEDS

In summary, most of the workforce needs for port electrification will be workers in the infrastructure area, vendor needs supporting Port equipment will also absorb new workers with new skills, and maintenance will likely be a retraining mission of existing workforce.

FTE NEEDED TO MEET ELECTRIFICATION GOALS



As the above graph shows, the training and skills development needs will favor infrastructure over vendors by approximately a 2:1 ratio. This has implications for the workforce development and skills training for each category, as well as the delivery of such training as much of the infrastructure will be re- or upskilling existing workforce. Having established the baseline of jobs and roles available we now turn to the skills required to fill those positions.

Two primary elements drive workforce skill development needs in ways that are not already addressed. The first is the new technology. Its production, deployment and maintenance are all based on existing positions but with new skills required. These can be met by either formal education or informal on-the-job training. One vendor remarked that he could not get workers trained with the skills he needed, so he preferred to hire eager workers with basic skills and train them on the job, developing workers with high potential in his domain. He would, of course, prefer to get quality individuals already possessing the requisite skills instead of investing work time and training time to get them up to speed.

The second unique element is the Port, especially for electrification, with its particular needs. Safety training in a demanding setting, especially concerning the corrosive elements of the port environment, requires special skills and know how. Again, this is often learned on the job but we believe that formal training would be more useful given the significant danger to mishandling high voltage equipment, and the very specific tools and methods required.

5.5.1 VENDOR SKILLS

While many of the skills are not entirely new, the combination of skills required is a change. The ability to work on electronic systems with embedded software is important for BEV and other electric equipment. This skill set is new to being coupled with automotive repair skills, thus as well as curriculum development, the packaging of training should be rethought. The increased prevalence of high voltage battery storage systems, in particular lithium ion variants, has a new set of safety skills required. Finally as Port electrification equipment is new and produced in small quantities, workers may rely on schematic reading and battery theory rather than well-defined diagnostic equipment. Our respondents identified these general skills across the board:

- Technicians with skills especially in electronics
- Battery theory and safety
- Schematic reading
- Basic automotive repair skills

5.5.2 INFRASTRUCTURE SKILLS

Almost all of the infrastructure will be installed in the Port by a few electrical contracting firms already qualified to do work on site. These firms use IBEW union labor for the most part, and the IBEW has continuing education to train existing skilled workers in new areas. While much of the work is an extension of existing work (for example, new circuits, conduit, cut-off systems, etc.) some of the equipment is unfamiliar and brand new to market. An example of this is automated/robotic charging devices for yard haulers. The equipment is new, the installation may not be standard, and both troubleshooting and planning require skills scarce in the workforce. In general, respondents mentioned the following higher level skills as important supporting port electrification:

- High voltage safety (existing workforce has this skill)
- Battery and charging station training
- Electrical systems in corrosive environment

06

SKILLS AND TRAINING GAP ANALYSIS

The Port, through the 2017 Clean Air Action Plan, has proposed ambitious zero-emissions goals including a complete transition to zero-emissions drayage trucks by 2035 and zero-emissions terminal equipment by 2030. The adoption of this new equipment will impact the existing and future workforce, and the readiness of labor to support this work is intimately tied to the Port's ability to achieve its zero-emission goals. In addition, the CEC has a growing interest in understanding the impact that the adoption and scaling of ZEV technology has on the workforce and, through this grant, has included funding for a workforce needs assessment and skills gap analysis.

This part of the analysis serves to inventory educational and training programs in the Los Angeles region, identify the existing assets, and develop recommendations on how to augment these programs to support the electrification of port terminal equipment and produce an area workforce with the requisite skills to operate and maintain zero-emission port equipment.

6.1 FEEDBACK FROM OEMS, TERMINAL OPERATORS AND SUBJECT MATTER EXPERTS

The needed skills and competencies for entry level and incumbent workers supporting the newly deployed zero emission vehicles were identified through a series of in-person and phone interviews with original equipment manufacturers (OEMs), terminal operators, labor representatives, and subject matter experts.

GRANT PARTNER INTERVIEWS FOR SKILLS AND COMPETENCIES	
ORGANIZATION	**ROLE**
BYD	OEM/Vendor
Cavotec	OEM/Vendor
IBEW Local 11	Labor
International Transportation Service	Terminal Operator
Long Beach Container Terminal	Terminal Operator
SSA Marine	Terminal Operator
Total Transport Services	Logistics Company
US Hybrid	OEM

In total, 29 competencies were identified and grouped into eight broad areas including:

- Battery Safety
- Battery Theory
- Charging Components
- Electrical Connections in Corrosive Environments
- Equipment Maintenance
- General Electrical
- Mechanical Aptitude
- Zero Emission Technology

In addition to identifying competencies, the interviews elucidated issues in the adoption and implementation environment, which will impact workforce. As referenced earlier, in several interviews, OEMs spoke about zero emission vehicle warranties and service contracts that would be offered to customers covering the life of the vehicles, meaning servicing and maintenance demands on existing labor may be minimal. In fact, several OEMs reported that they were considering proposals where included in the purchase of the vehicles would be service visits by technicians from the manufacturers, eliminating the need for local labor to maintain and service the ZEVs on site. Several details remain to be ironed out, including response time, union contracts, location of spare parts and maintenance facilities. For some equipment with complex systems the operators would like vendor support, but feel other routine maintenance activities could be handled by internal resources.

Manufacturers are still testing the ZEV technology and are highly motivated to track any service calls and repairs for ongoing improvements as well as guarding this information from a competitive standpoint. They are incentivized to cover the cost of lifetime service contracts to be able to collect and protect the data. In addition, OEMs may not provide full-service manuals and diagnostic equipment to customers, further preventing local onsite labor from maintaining vehicles. OEMs in most cases, however, will provide training to customers for drivers new to operating electric vehicles.

Both OEMs and terminal operators reported that servicing these electric vehicles is less labor intensive than diesel and believed that existing mechanics should be able to service these new vehicles with current skills and minimal training. In the case that an OEM would allow local labor to maintain and service the ZEVs, OEMs and those terminal operators familiar with the vehicles described maintenance as being less about repairing faulty equipment and more about removing an entire component and replacing it with an entirely new component. This replacement could indeed be done on site by local labor, but in effect no repairs are being made, only replacements of components. OEMs and terminal operators described these replacements as requiring less technical skills and more safety skills.

Regarding retraining, one open question from terminal operators and OEMs was how to address the role of refuelers and suggested they would need to be retrained or take on other roles since the new electric vehicles would not need fueling but would rather be on a charging schedule. Additionally, while the work is similar in function (keeping equipment operating through multiple shifts) the specific tasks, as defined in labor agreements, are different and the safety training is different. Some vendors are looking at robotic charging equipment to solve this problem, but this is at an early staga.

In addition to the vehicles, new charging infrastructure will also be installed. In the Port of Long Beach, it is the tenants' or the terminal operators' responsibility to maintain this equipment. Maintenanca and installation of high voltage equipment is currently done by existing approved vendors working in the Port with highly skilled electrical workers. Grant partners felt that these workers would already have skills needed to install and work on this new infrastructure and if not, tha IBEW represents the vast majority of the workers and is positioned to provide the retraining or upskilling needed.

6.2 IDENTIFIED COMPETENCIES AND SKILLS

Data for the gap analysis of existing programs was collected from 23 colleges through faculty and department head interviaws, surveys, and reviewing program catalogs and coursa content. In addition to an inventory and anelysis of the existing training and education available, the analysis identified the skills and competencies needed to maintain and service the new electric vehicles. This data was collected through interviews with representatives from terminal operators, OEMs, labor, and other subject matter experts.

On the next page is a chart of specific skills and competencies that we were able to identify through surveys with grant partners as well as other industry experts and faculty. This chart serves as a guide for trainers and educators preparing entry level workers, or retraining those that work with diesel equipment, to service and maintain zero emissions vehicles and equipment.

IDENTIFIED COMPETENCIES
FOR INCUMBENT AND ENTRY LEVEL WORKERS SUPPORTING
NEW ZERO EMISSIONS VEHICLES

Zero Emission Technology

- Determining system-wide impact of zero emission technology adoption on production and efficiencies
- Zero emission technology adoption and scalability modeling
- Master planning for facility needs of zero emission technology integration and adoption

Battery Theory

- General overview of basic principles of batteries
- Knowledge of basic battery operations
- Understanding of the different types of batteries
- Electrical characteristics of various battery types

Battery Safety

- Understanding hazards associated with industrial batteries
- Electrical safety precautions when working with batteries
- Fire and explosion precautions
- Safe handling of batteries
- Proper safety equipment needed when working with batteries

Electrical Connections in Corrosive Environments

- Understanding basic electrical connections
- Knowledge of how corrosive environments impact electrical connections
- Overview of variety of wire materials used in various corrosive environments
- Working safely with electrical connections in corrosive environments

Charging Components

- Understanding of charging components and terms
- Knowledge of charging requirements and connector types
- Knowledge of basic safety surrounding charging

Mechanical Aptitude

- General aptitude for mechanical work
- Knowledge of general automotive/mechanic repair skills
- Use of standard tools and hardware

Equipment Maintenance

- Understanding component diagnostics
- Safely removing non-functioning components
- Safely installing new or repaired components

General Electrical

- Reading and understanding electrical schematics
- Knowledge of common figure identifications
- Overview of basic circuitry components
- Knowledge and use of electrical diagnostic tools

6.3 COMMUNITY COLLEGE DATA COLLECTION

The California Community College system is the largest higher education system in the nation with 2.1 million students attending 155 colleges. Community colleges do not have admission requirements beyond a high school diploma or equivalent, and fees are $46 per unit, making them the most accessible college education available. This system of colleges continues to serve as an affordable and accessible education and workforce training resource for students in underserved and underrepresented communities.

Community colleges provide the hands-on training and education needed for occupations in the trades and technical industries and are where students can secure certificates, degrees, and short-term training for Port-related careers. As a result, the gap analysis focused on assessing community college programs and their readiness for preparing future and incumbent workers to support zero emission heavy-duty vehicles.

We reviewed 23 colleges in the Los Angeles and Orange County area looking for those that at minimum had an electrical and/or advanced transportation and alternative fuels program or classes. This, we presumed, would provide a universe of colleges that already had existing infrastructure, faculty, and curriculum in the areas of interest to the Port and may even have existing training in zero emissions equipment and infrastructure or at least a foundation from which to build upon.

COMMUNITY COLLEGE PROGRAMS REVIEWED FOR RELEVANT CURRICULUM		
Cerritos College	Golden West College	Orange Coast College
Citrus College	Los Angeles City College	Pasadena City College
Coastline College	Los Angeles Pierce College	Rio Hondo College
Cypress College	Los Angeles Southwest College	Saddleback College
East Los Angeles College	Los Angeles Trade Tech College	Santa Ana College
El Camino College	Los Angeles Valley College	Santa Monica College
Fullerton College	Long Beach City College	Santiago Canyon College
Glendale College	Mt. San Antonio College	

Data about the college programs were collected through online surveys, one-on-one interviews, and an assessment of curriculum and program information available online. Survey and interview participants included faculty and department heads from electrical and advanced transportation programs.

6.3.1 COMMUNITY COLLEGE DATA COLLECTION

Through interviews, surveys and the review of course details and program offerings in the 23 colleges, we aliminated those that had automotive programs focusing on auto repair and body work rather than advanced transportation. We also eliminated electrical programs that focused more on electronics. Regionally we identified thirteen colleges with an advancad transportation program, six with an electrical program, and five with both programs.

OVERVIEW OF RELEVANT COMMUNITY COLLEGE PROGRAMS		
PROGRAMS AND CONTENT	YES	NO
Does college have an Advanced Transportation degree and/or certificate?	13	10
Does college have an Electrical Technology degree and/or certificate?	6	17
Does the Advanced Transportation program include electric/hybrid vehicles or zero emissions technology content?	13	0
Does the Electrical program include zero emissions technology content?	4	2

The table below shows those schools that offer Advanced Transportation (AT) programs including short-term certificates and degrees. AT programs are designed to train students to service and maintain alternative fuel vehicles. This may include LNG, CNG, and/or electrical and hybrid. Some focus only on light- or medium-duty engines and some include heavy-duty.

COLLEGES OFFERING ADVANCED TRANSPORTATION (AT) DEGREES AND/OR CERTIFICATES		
Cerritos College	El Camino College	Pasadena City College
Citrus College	Golden West College	Rio Hondo College
Cypress College	Los Angeles Pierce College	Saddleback College
East Los Angeles College	Los Angeles Trade Tech College	Santa Ana College
	Long Beach City College	

Our analysis of survey data, interviews, and coursework available to review online, found that of those 13 colleges with advanced transportation programs all included zero emissions technology in some coursework. Interviews found that most of the programs focused on light duty and not heavy-duty vehicles.

COLLEGES OFFERING ELECTRICAL DEGREES AND/OR CERTIFICATES		
East Los Angeles College	Los Angeles Trade Tech College	Orange Coast College*
Los Angeles Pierce College*	Long Beach City College	Rio Hondo College
*can't confirm ZEV course content		

Only six colleges offered an electrical degree or certificate, and within those electrical programs, four integrated zero emission concepts. This suggests that the study of zero emissions technology and vehicles is not seen as only being in the purview of electrical programs by colleges, but is being integrated into advanced transportation programs to a great extent.

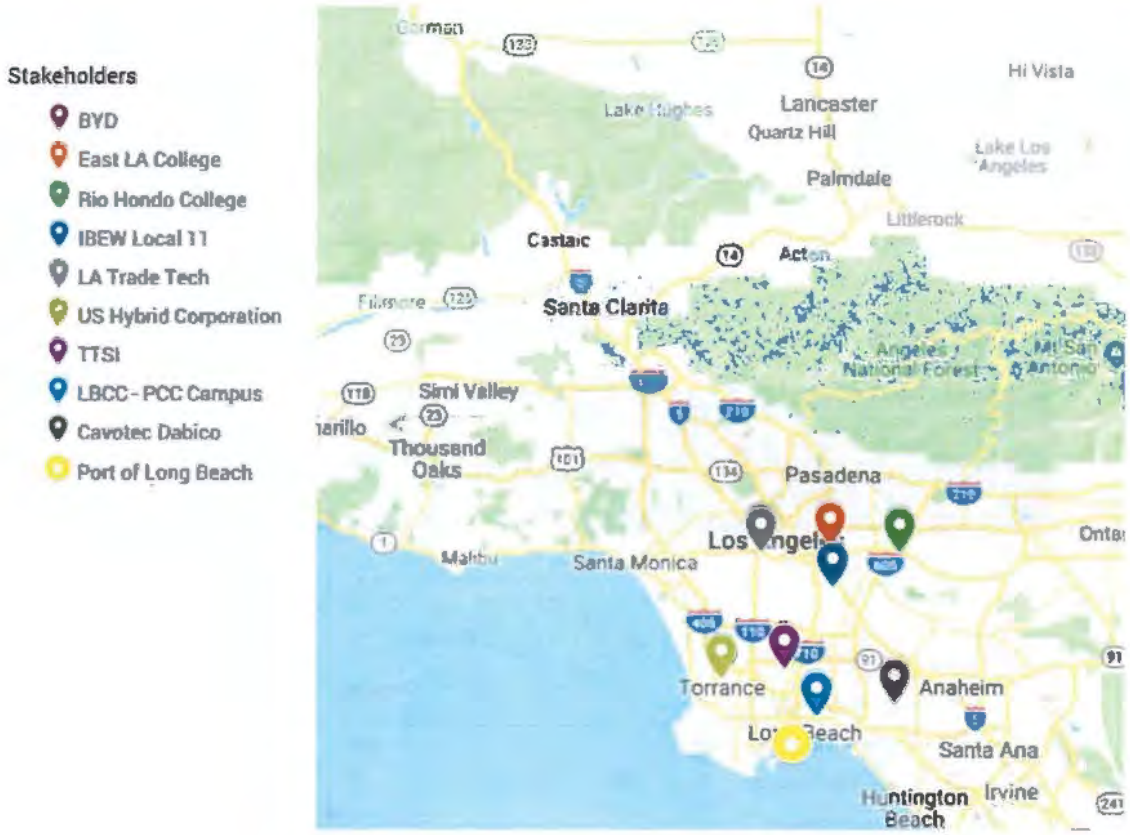
COLLEGE ADVANCED TRANSPORTATION PROGRAMS INCLUDING ZEV CONTENT	
Cerritos College	Alternative fuel service and electric vehicle technology courses
Citrus College	Hybrid and electric vehicle courses including Toyota Prius sponsorship
Cypress College	Toyota T-Ten program working with Toyota hybrid and electric vehicles
East Los Angeles College	Hybrid service and technology course
El Camino College	Electric and hybrid technology courses
Golden West Collega	Electric and hybrid technology courses
Los Angeles Pierce College	Hybrid and electric service and safety course and an alternative fuels course
Los Angeles Trade Tech	Intro to alternative fuels course and several hybrid and electric courses
Long Beach City College	Hybrid and electric vehicle courses and Associate in Science (AS) degrees in Alternative Fuels and another in Electric Vehicles
Pasadena City College	Hybrid repair and diagnostic certification program
Rio Hondo College	Alternative Fuels Associate in Science (AS) degree for hybrid and electric vehicle technology and Electric Vehicle and Fuel Cell Technician program
Saddleback College	Alternative Propulsion Systems course and a hybrid and electric vehicle course
Santa Ana College	Alternative fuels and hybrid vehicles courses

Below is a table of the four colleges that offer both Electrical and AT programs that integrate ZEV content into their courses. It is these colleges that have a head start in the region on preparing the workforce needed to support and work within a ZEV environment.

COLLEGES OFFERING ADVANCED TRANSPORTATION (AT) DEGREES AND/OR CERTIFICATES THAT INCLUDE ZEV CONTENT	
East Los Angeles College	Long Beach City College
Los Angeles Trade Tech College	Rio Hondo College

The map below provides an overview of these regional community college assets and their proximity to the partner vendors as well as to the Port. The farthest distances being from the Port to Rio Hondo College at 26 miles, and LA Trade Tech at 25 miles.

PROXIMITY OF COLLEGES, MANUFACTURERS, AND IBEW TO THE PORT OF LONG BEACH



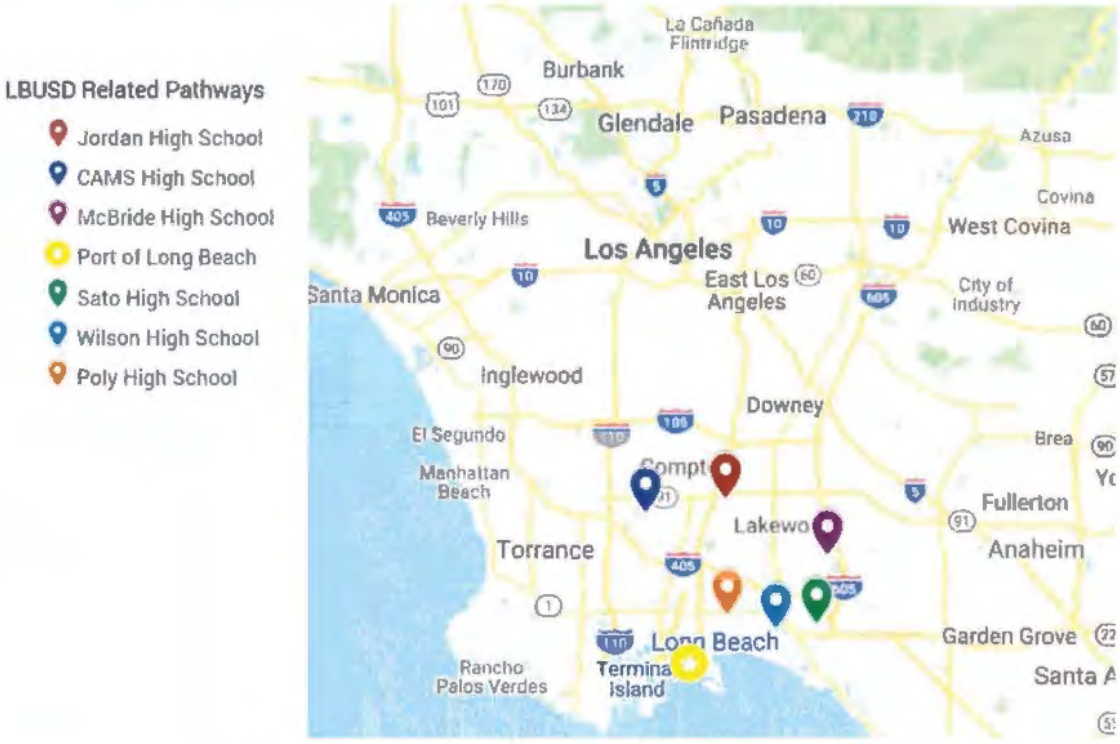
6.4 PATHWAYS OF STUDY IN LONG BEACH UNIFIED SCHOOL DISTRICT

Long Beach Unified School District is a linked learning district, meaning that each of the 14 comprehensive high schools have been converted into industry-themed pathways from 9th-12th grades. Students enter as freshmen into industry academies or pathways of study where they stay for their high school career. These industry themes include construction, business and finance, energy environment and utilities, engineering and architecture, and others. In addition to inventorying the community college programs, we also reviewed high school offerings to see where there was an introduction to zero emissions concepts or technology.

RELATED INDUSTRY-THEMED HIGH SCHOOL PATHWAYS IN LBUSD	
HIGH SCHOOL	**PATHWAY**
Cabrillo High School	Engineering and Architecture
California Academy of Mathematics and Science	Engineering and Architecture
Jordan High School	Engineering and Architecture, and Building and Construction Trades
Long Beach Polytechnic High School	Engineering and Architecture
McBride High School	Engineering and Architecture
Sato High School	Engineering and Architecture

The above table shows the high schools in LBUSD that have one or more pathways of study on their campuses related to the Port's zero emissions work. In addition, those schools highlighted GREEN also have GreenpowerUSA Electric Car programs described on the next page. The map below shows a distribution of those schools with pathways related to the Port's electrification work. There is a good geographic distribution of programs throughout the city offering access to students throughout Long Beach.

INDUSTRY-THEMED HIGH SCHOOL PATHWAYS IN LONG BEACH UNIFIED SCHOOL DISTRICT



The table below shows all the LBUSD high and middle schools that may not have a related pathway but have adopted the GreenpowerUSA program.

LONG BEACH UNIFIED SCHOOL DISTRICT MIDDLE AND HIGH SCHOOLS WITH GREENPOWERUSA ELECTRIC CAR PROGRAMS	
Cabrillo High School	McBride High School
California Academy of Mathematics and Science	Millikan High School
Jordan High School	Sato High School
Lindbergh Middle School	Stephens Middle School
Long Beach Polytechnic High School	

GreenpowerUSA is an international nonprofit organization focused on advancing sustainable engineering and technology in K-12 education. Greenpower runs engineering challenges for schools based around designing and building a single seat electric-powered race car. This type of program introduces the concepts of electric vehicles to middle and high school students and connects it to project-based learning activities. While these are not heavy-duty vehicles, these programs are designed to introduce careers and industries to students early in their education broadening the pipeline of future workers and creating entry points for the Port to work with engaged students.

In addition to the related pathways, which offer full immersion in the industry of study, these Greenpower schools have at least one teacher who has brought the program to their campus and showed an interest in introducing students to electric vehicle technology.

6.5 IBEW APPRENTICESHIPS AND TRAINING

The Port has partnered on this demonstration project with IBEW Local 11 who represent most of the electrical workers supporting activities in and around the Port. IBEW has been a leader in providing training to support electric vehicles and infrastructure for years. Local 11, which covers the greater Los Angeles area, currently represents 11,700 members and in 2018 they accepted 600 new apprentices. They continue to train new apprentices and retrain and upskill existing members to work in the growing field of zero emissions technology and are an important partner in the Port's zero emissions goals. They also have assets to bring to the table in support of this work.

In addition to the traditional apprenticeship path, IBEW offers the Electric Vehicle Infrastructure Training Program (EVITP) — the highest standard in training and certification for the installation of electric vehicle infrastructure. EVITP is a partnership of stakeholders from the electric vehicle industry with over 3,000 certified electricians. EVITP partners include vehicle and battery storage manufacturers, utilities, and research centers. The training is available to all California state certified general electricians and prepares them to support residential, commercial, public and fleet vehicles and infrastructure. EVITP was offered in the past at a few community colleges until they were dropped due to low attendance potentially related to low EV sales. It is now only offered occasionally at the Electrical Training Institute in Commerce. Long Beach City College has hosted this training in the past and is exploring hosting it again.

6.6 NOT-FOR-CREDIT TRAININGS

California Community Colleges have a special designation of "not-for-credit" for training classes that do not bear credits and do not require enrollment into the college. Typically, these trainings target incumbent workers and act as professional development. In some cases, the trainings can be fast-tracked skills attainment programs to help prepare community members for entry-level positions in industries with occupations that have a high need for workers.

Several community colleges in the region have not-for-credit offerings for incumbent workers in the area of advanced transportation. These classes are fee-based and operate on full cost-recovery, rather than being priced on a per unit basis. Employers often pay training fees for their workers to attend the trainings, or they take advantage (if they qualify) for funding from the State to subsidize training fees.

In California, this subsidization is handled through the Employment Training Panel (ETP). Employers have access to these funds to help support the retraining and upskilling of their incumbent workers. ETP was created in 1982 by the California State Legislature and is funded by California employers through a special payroll tax. This funding supported training for almost 9,000 workers last year. In many cases, training providers are community colleges that partner with the ETP to provide needed skills-based training to local industry. Long Beach City College, in partnership with Cerritos and El Camino Colleges, has provided ETP training for years in the areas of advanced transportation and in logistics.

Regionally, Long Beach City, Cerritos, and LA Trade Tech Colleges offer not-for-credit training in the area of alternative fuels. The chart below highlights the training courses most relevant to the skills areas identified in the gap analysis.

NOT-FOR-CREDIT TRAININGS	
COLLEGES	**CONTENT AREA**
Long Beach City College; Los Angeles Trade Tech; Cerritos College	Electrical - Understanding electrical systmes; reading schematics; diagnosis and repair; introduction to PLC (Programmable Logic Controller computer) and data networks
Long Beach City College; Los Angeles Trade Tech	Hybrid safety - safety and familiarization; understanding of high voltage and standard safety practices for battery removal
Los Angeles Trade Tech	Hybrid Preventative Maintenance and Diagnostics - understanding requirements for PM for industrial hybrid vehicles; diagnostics software use and diagnostics skills
Cerritos College	A/C Systems in Hybrid Electric Vehicles - understanding diagnosis, and repair of air conditioning shystems in hybrid electric vehicles
Los Angeles Trade Tech	Electric Zero Emission Familiarization - introduction to working on wholly electric ZEV vehicles

The current not-for-credit offerings focus heavily on electrical systems in general, with only one college offering specific ZEV trainings. The not-for-credit training area can be enhanced quite easily with funding to develop new content, and given that development of training content can be done quickly, this could be a fast and easily customizable solution to interim skills gaps issues.

07

RECOMMENDATIONS TO ADDRESS FUTURE WORKFORCE NEEDS

Community colleges play a key role in training the hands-on skills-based workers needed to manufacture, maintain and operate the existing and new ZEV equipment and vehicles in the Port. Adoption success is intimately tied to community colleges' ability to be a part of the conversation to understand the new technology and the skills workers will need to support it. This analysis provides a valuable tool to both communicate the Port's work directly to colleges, as well as to communicate their assets and their struggles directly to the California Energy Commission.

The region also has training assets in its union partners, in particular IBEW who is on the cutting edge of technology adoption and training. In addition, California employers have the benefit of their pooled funds to support ETP training provided through community colleges, labor partners, and private providers.

Lastly, Long Beach Unified School District has led the charge in transforming all their comprehensive high schools into linked learning pathways with industry focuses and workplace learning opportunities at the core of the classroom. Many of the existing pathways in Long Beach have connections to the work of the Port. This section outlines recommendations for these key partners.

7.1 COMMUNITY COLLEGE TRAINING FOR ENTRY LEVEL WORKERS

We have been able to identify four regional colleges that have both advanced transportation programs and electrical programs as well as already integrate zero emissions technology concepts into their curriculum. These colleges are also geographically diverse providing the larger community greater access to their training and education programs. In addition, there are 13 that have advanced transportation programs with zero emissions concepts integrated. Related, LBCC has an agreement with the IBEW Local 11 to provide apprenticeship credit for students that enter their program with a degree from LBCC. This helps to provide an attractive pathway for students into a career supporting this new technology.

These existing programs provide a solid foundation for which to continue to build, and we as a region are by no means starting from scratch in building out certificates and degrees to meet the needs of the future workforce.

RECOMMENDATIONS FOR COMMUNITY COLLEGES SERVING ENTRY LEVEL WORKERS:

Review the skills outlined in this report. These competencies were identified by industry as critical needs for workers due to the anticipated increase in electrification of vehicles and equipment (and the associated infrastructure). Colleges can use this information to modify existing programs in such a way as to enhance students' readiness for the expanded use of ZEVs in industry.

Develop cross-disciplinary programs. While all regional community college advanced transportation programs touched in some manner on ZEV, the infrastructure curriculum is typically housed in electrical programs. Given the intersection of advanced transportation and electrical programs in real world applications, it behooves students who are majoring in one discipline to take courses in the other discipline. Certificates that package classes from both programs are a way to encourage students to self-select a cross-disciplinary course selection. Ideally, associate's degrees themselves should have cross-disciplinary approaches as well.

Create non-credit exploratory courses/certificates. Non-Credit courses require enrollment in the college but are not credit bearing. These courses are often used to provide Basic Adult Education to help individuals become college ready, but they are also used to deliver occupational education fundamentals, such as courses to learn the Microsoft Suite of programs. Non-Credit introductory courses/certificates in Advanced Transportation and Electrical can provide general preparation for the credit programs and act as pipelines into the programs.

Meet as a workgroup with other colleges. The robustness of the existing programs vary and there's value in coming together as a workgroup once or twice a year to share challenges and successes.

Work with the Los Angeles Economic Development Corporation (LAEDC). The LAEDC's Center for a Competitive Workforce is already partnered and receiving funding to work with the regional colleges and can provide a wealth of knowledge regarding labor market demand, internships, and growth, as well as direct connections with companies not only for hiring opportunities, but also for work-based learning opportunities integrating them into the classroom experience.

Seek funding for faculty professional development in this new technology as well as for industry engagement events.

Expand the number of colleges who serve as feeders to the IBEW. This typically requires a robust associate's degree program that will meet the rigor of the IBEW apprenticeship, which is one of the more challenging unions to enter.

Actively follow the Ports of Long Beach and Los Angeles's progress in adopting this new technology. The Ports are leading the charge in ZEV adoption. Long Beach, especially, is really pushing the envelope on electrification of new types of equipment. Their activities in this arena will invariably predict similar efforts to come in the wider sector and can help colleges get ahead of the curve when it comes to having relevant and on-demand programming.

7.2 LBUSD PATHWAYS

Long Beach is already ahead of many cities across the nation with the full implementation of linked learning. There are school-based resources and lead instructors whose job it is to make robust connections with industry partners bringing their talent into the classroom and students into their workplaces. We have identified seven high schools with related pathways and in fact there are nine middle and high schools that are actively interested in electric vehicle technology as evidenced by their implementation of the GreenpowerUSA programs. Locally, LBCC works closely with LBUSD on offering college level courses to students on campus and even at the high schools, but there's always room for growth.

Recommendations for LBCC and LBUSD:

- Expand dual enrollment efforts on electrical and or advanced transportation programs
- Engage high schools in LBCC career fairs and industry events focused on zero emissions technology

7.3 INCUMBENT WORKER TRAINING

Community colleges are able to offer education and training in a variety of forms – credit bearing courses, non-credit workforce or ESL-focused courses, fee-based professional development and training courses, or, where available, ETP-funded training. While the process for creating and adopting new certificates and degrees can take six to eight months or more, the good news is that the region already has many assets in this area. Existing workers or returning students can choose from a variety of credit bearing courses throughout the region to receive ongoing training and professional development.

In addition, as mentioned above, several regional colleges offer fee-based training that is typically short term, as short as eight hours or as many as 150, with flexible schedules, and tied to specific occupations or careers. LBCC offers these types of courses in advanced transportation. ETP is also a valuable tool for incumbent workers and employers to leverage for upskilling. As described earlier, IBEW offers EVITP training and certification for the installation of electric vehicle infrastructure. This is a tremendous asset regionally for existing electricians who want to begin working with electric vehicles and infrastructure.

7.4 CEC AND PORT

The bulk of the work of educating and training the future and incumbent workforce will fall to community colleges and to our labor partners. Community colleges work with a unique set of challenges, and a lack of flexible funding is the greatest. Colleges have the talent in their faculty, tha tools and equipment in their labs, and a captive and eager audience in their students. What we lack however, is funding to be able to quickly develop training in response to changing technologies and industries' demands. With additional flexible funding for short term incumbent worker training, we are not only able to meet the immediate needs of local industry, but also pilot new curriculum that can then be integrated into our existing credit bearing certificates and degrees updating those programs to better prepare the future workforce.

RECOMMENDATIONS FOR THE CEC:

- Provide new funding to educational institutions and labor partners to create short term training for entry level positions and retraining incumbent workers.
- Continue to provide funding for workforce assessments within infrastructure and equipment demonstration grants as a way to continue to connect workforce needs with adoption at the systems level and with on the ground partner evaluations.
- Create convening opportunities between grantaes and adopters of new equipment and infrastructure, and the educational, labor, and workforce development partners.

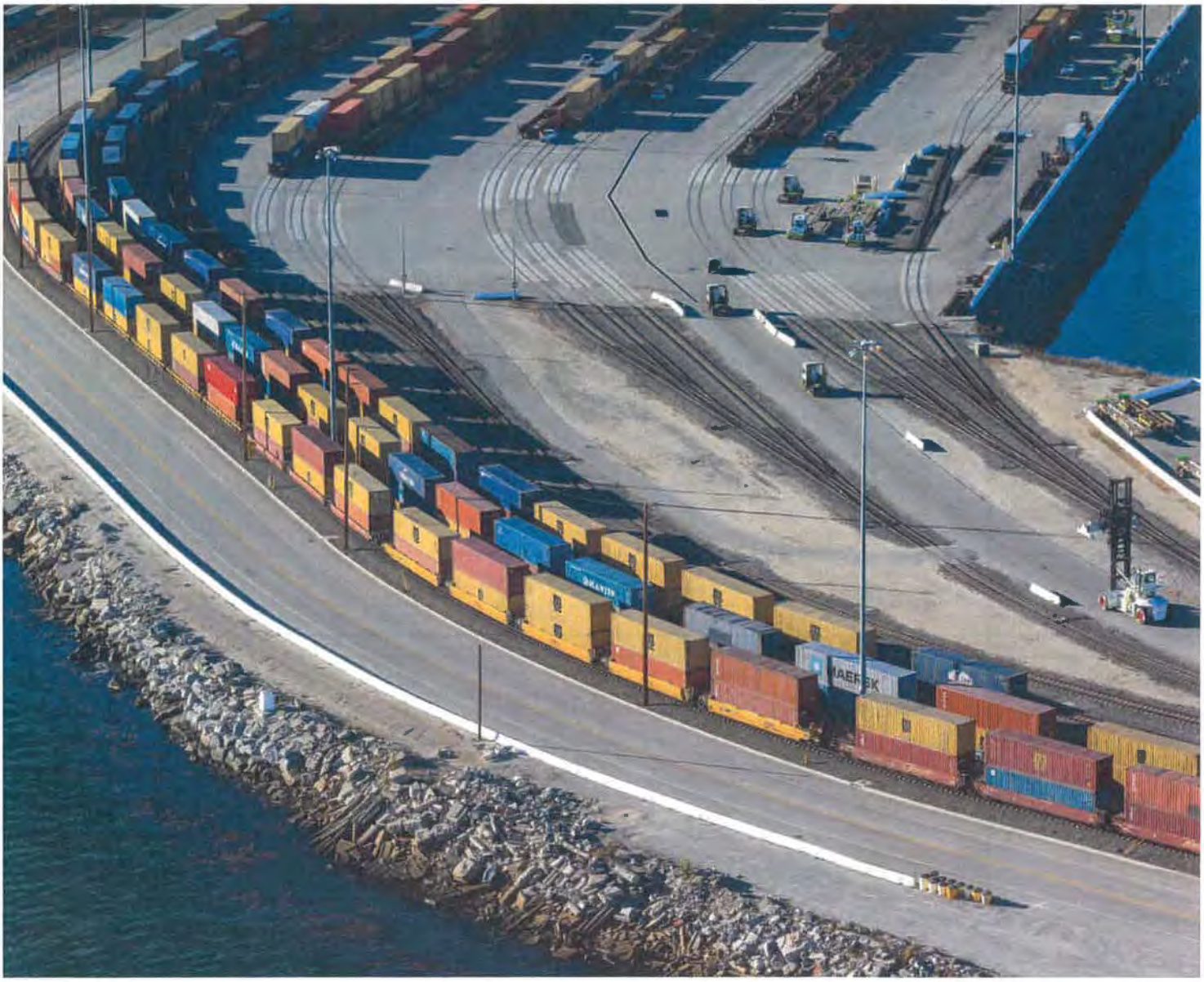
RECOMMENDATIONS FOR THE PORT:

- Provide new funding to educational institutions and labor partners to create short term training for entry level positions and retraining incumbent workers.
- Continue to partner with educational partners, when appropriate on workforce studies.
- Continue to shara the zero emissions work with K-12 and higher education systems through symposiums or workshops for educators.

08

SUPPORTING DOCUMENTS

- January 23, 2018 PowerPoint Presentation to the Port and Stakeholders
- April 5, 2018 PowerPoint Presentation to the Port and Stakeholders
- June 7, 2018 PowerPoint Presentation to the CEC and California Ports
- November 1, 2018 PowerPoint to LBUSD Educators
- November 7, 2018 PowerPoint Presentation to the Academy of Global Logistics



JANUARY 23, 2018

POWERPOINT PRESENTATION TO THE PORT AND STAKEHOLDERS

LONG BEACH CITY COLLEGE

Zero-Emission Port Equipment Workforce Assessment

January 23, 2018

www.lbcc.edu

LONG BEACH CITY COLLEGE

Agenda

- Introductions
- Grant Background
- Assessment Approach
- Scope and Timeline
- Update on Workforce Report
- Feedback

www.lbcc.edu

Introduction

- LBCC
  - Melissa Infusino, Workforce Development Director for Long Beach City College
  - Dana Friez, Workforce Development Training Manager
- Advanced Sustainability Institute
  - Michael Boehm, Managing Director
  - Jennifer Bredell, Project Manager

www.lbcc.edu

CEC Grant Background

- California Energy Commission Grant for demonstration project of Zero Emission Cargo-handling Equipment
- Vendors Cavotec, BYD, and US Hybrid will design and manufacture a total of 25 new or converted electrified cargo handling vehicles for the terminal operators ITS, LBCT, and SSA Marine as well as TTSI

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LONG BEACH CITY COLLEGE

LBCC Scope of Work

- Quantify electrification progress and predict ramp up numbers for the pilot, 3 year, 5 year, and 12 year intervals
- Identify workforce needs to produce, operate and maintain electrification equipment
- Identify gaps in workforce skills and education and training programs to address these gaps

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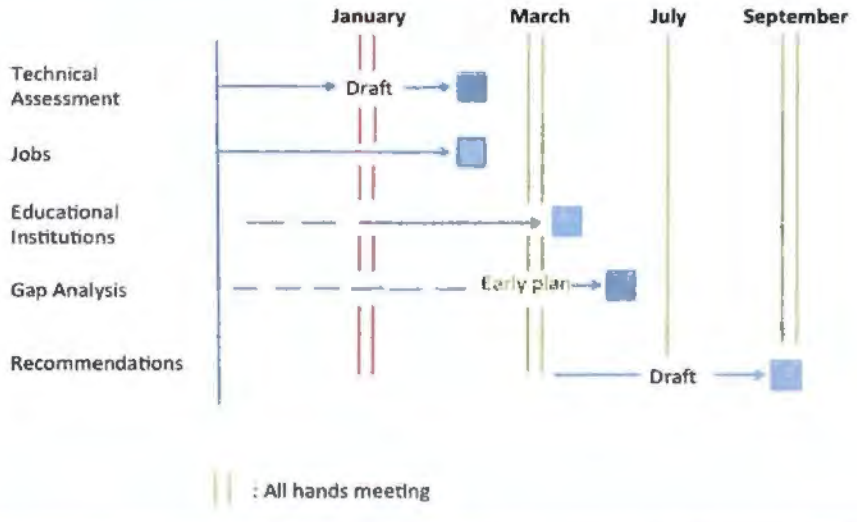
LONG BEACH CITY COLLEGE

Project Timeline



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Assessment Approach

1. Research
   - Reports from various sources, e.g. Ports of Los Angeles and Long Beach, Fleet Manager, EPRI etc.
2. Interviews
   - Interviews with terminal operators, technology vendors, Port, unions
3. Projections
   - Electric powered equipment units adopted
   - Jobs and needed skills to support electrification

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Port Comparison

Port of Busan

- "Busan North Port" has converted most of their equipment to electric
- 4 ports in total are fully equipped modern ports with automation
- Limited scope of project

© Port of Rotterdam

Port of Rotterdam

- Maasvlakte 2 Terminal at Port of Rotterdam is fully electric with power generated by wind turbines
- Additional two terminals are operated by automated equipment
- Emphasis on sustainability, such as renewable energy and energy recycling programs
- Limited scope of project

© Port of Busan

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Economic Drivers

- Reduced Operation and Maintenance Costs
  - Avoided Fuel Costs, electricity typically 1/3 cost
  - Fewer Worn Parts and Reduced Engine Usage
  - Less Frequent Service and Inspection Intervals
  - TCO for Fleets typically 4 years
- Adjust Before Regulation
  - Anticipates ZEV port by 2030 target
- Yard Hauler Costs Should Go Down
  - Currently produced on small assembly lines, scaled production should generate savings
  - Battery storage a major cost contributor to Yard Hauler cost (and possibly new versions of eRTG) and costs are dropping rapidly, will likely lead to a late surge in BEVs
  - Typically there is a replacement cycle of 12 years so if BEV adoption happens that should encourage replacement of end of life assets, which would spread the adoption around more evenly
- Electrical charging infrastructure will remain a barrier to adoption unless incentives are found as TCO numbers will be skewed negatively with the more expensive charging infrastructure up front expense for heavy duty vehicles

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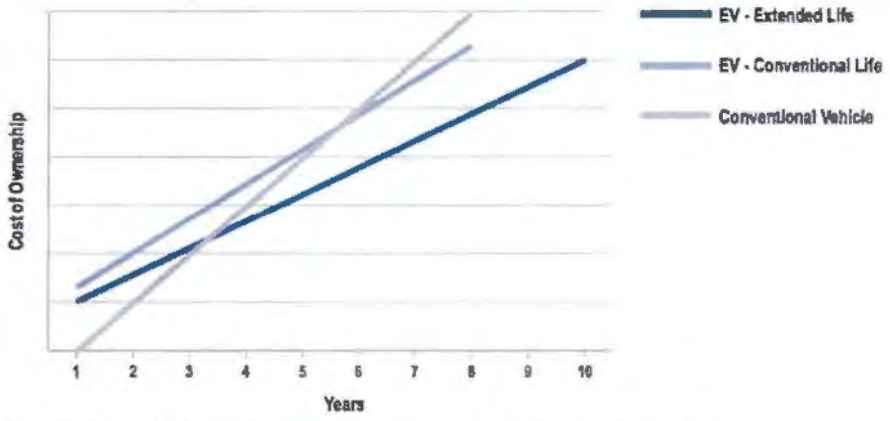
Fleet BEV TCO



BEV = Battery Electric Vehicles
TCO = Total Cost of Ownership

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Methodology

- Adoption of Innovation
  - Bell curve or S curve?
  - Infrastructure costs high
  - ZEV target in 2030 driving adoption
  - We estimated % of total (and thus real #s) of new electric equipment rolled out per year
- Labor Needs
  - Used joint 2017 Port report to estimate infrastructure
  - Rough estimates from vendors for labor

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LONG BEACH CITY COLLEGE

Yard Hauler Adoption

Year		18	19	20	21	22	23	24	25	26	27	28	30	Total
% Adoption		4%	4%	5%	5%	6%	6%	6%	8%	10%	10%	12%	15%	100%
BEV Yard Hauler	9	32	32	40	40	48	55	63	71	87	95	111	119	801
HBEV Yard Hauler	5	1	1	1	1	2	2	2	3	3	3	4	4	34
Infrastructure	51	14	14	18	18	21	25	28	32	39	42	49	53	53
Vendor	13	3	3	4	4	5	6	7	8	9	10	12	13	13

- Projected units and labor component of Install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in Electric Power technology to support new vehicles

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LONG BEACH CITY COLLEGE

eRTG Adoption

Year		18	19	20	21	22	23	24	25	26	27	28	30	Total
% Adoption		2%	3%	4%	4%	6%	6%	8%	8%	10%	10%	12%	15%	100%
eRTG	9	1	2	3	3	4	4	6	6	7	7	9	11	71
Infrastructure	10	30	30	41	41	50	50	66	66	83	83	99	124	124
Vendor	5	15	15	21	21	25	25	34	34	42	42	50	63	63

- Projected units and labor component of install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in BEV to support new vehicles

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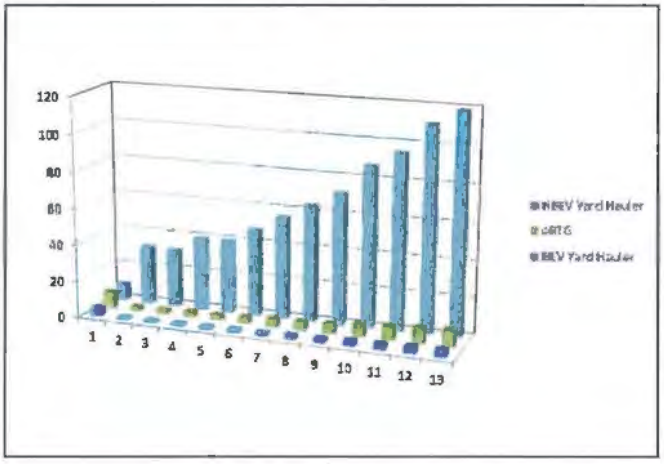
LONG BEACH CITY COLLEGE

Equipment Projections

- POLB data used for infrastructure/vehicle total population
- HBEV likely interim solution towards ZEV
- Fuel Cell may emerge but this study focuses on pilot equipment
- Adoption curve slow at start, builds to meet 2030 target
- Year 1 = pilot, 2017 - Year 13 = 2030



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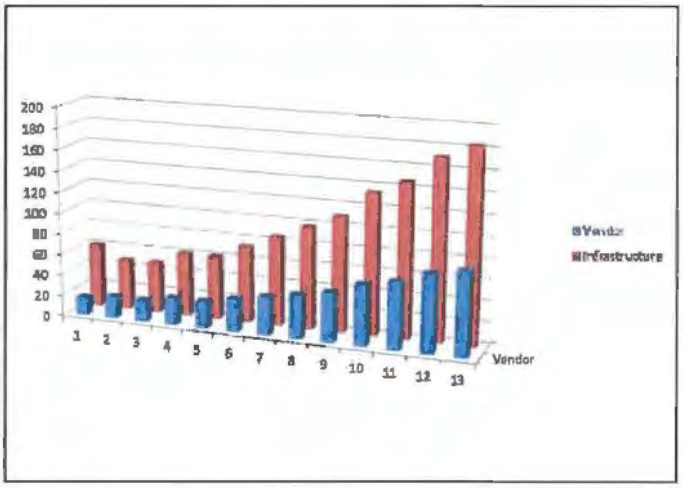
New Jobs Projections

- POLB data used for infrastructure/vehicle ratio
- Maintenance hours decrease, retraining useful
- Infrastructure jobs driven by adoption, largest gains
- Vendors are local, so additional jobs for production counted
- Year 1 = pilot, 2017 - Year 13 = 2030



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Skills Needed

- Vendors
  - Technicians with skills especially in electronics
  - Battery theory and safety
  - Schematic reading
  - Basic automotive repair skills
- Infrastructure
  - High voltage safety (existing work force has this skill)
  - Battery and charging station training
  - Electrical systems in corrosive environment

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Training Considerations

- Training opportunities for those in maintenance roles
- Opportunities to partner with Vendors and trade unions on training
- Vendors report spare parts logistics keeps equipment local
  - Maintenance may shift to vendors (local jobs)
  - On site maintenance may shift to diagnostics and component swaps (e.g. battery or motor)
- Early HBEV study showed that users liked equipment but needed training, documentation light for early stage equipment
- Local community colleges have degree, certificate, and training programs in place which can be built upon

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Training Resources

Early Inventory Found:

- Nine Colleges with both electrical and automotive programs
  - Cerritos, El Camino, Fullerton, LA Trade Tech, LBCC, Pasadena, Saddleback, Santa Ana, and Rio Hondo
- Four Colleges with Alternative Fuel Programs
  - LA Trade Tech, LBCC, Rio Hondo, and Saddleback College, (Rio Hondo has an AS degree in Alt Fuels)
- 15 Colleges with some related training program

Next step is surveying colleges on specific skills training.

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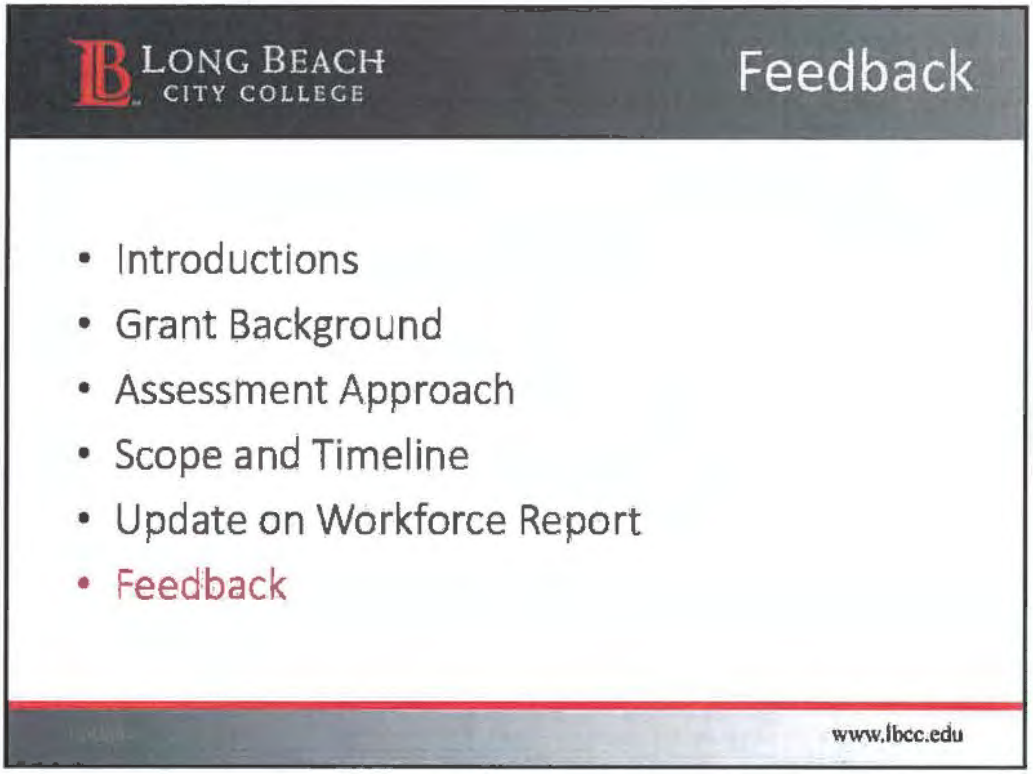
LONG BEACH
CITY COLLEGE
Feedback
• Introductions
• Grant Background
• Assessment Approach
• Scope and Timeline
• Update on Workforce Report
• Feedback
www.lbcc.edu

APRIL 5, 2018

POWERPOINT PRESENTATION TO THE PORT AND STAKEHOLDERS

LONG BEACH CITY COLLEGE

Zero-Emission Port Equipment Workforce Assessment

April 5, 2018

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LONG BEACH CITY COLLEGE

Agenda

1. Introductions
2. Scope and Timeline (Information)
3. Adoption Projection Updates (Information)
4. Report Outline (Need Feedback)
5. Skills Analysis (Need Feedback)
6. Questions

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LONG BEACH CITY COLLEGE

Introduction

- LBCC
  - Melissa Infusino, Workforce Development Director for Long Beach City College
  - Dana Friez, Workforce Development Training Manager
- Advanced Sustainability Institute
  - Michael Boehm, Managing Director
  - Jennifer Bredell, Project Manager

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Grant Background

- California Energy Commission Grant for demonstration project of Zero Emission Cargo-handling Equipment
- **Vendors Cavotec, BYD, and US Hybrid will design and manufacture a total of 25 new or converted electrified cargo handling vehicles for the terminal operators ITS, LBCT, and SSA Marine as well as TTSI**

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Scope of Project

1. Project ZEV equipment adoption for the pilot and annual levels for 12 years
2. Identify workforce needs to produce, operate and maintain electrification equipment
3. Identify gaps in workforce skills and education and training programs to address these gaps

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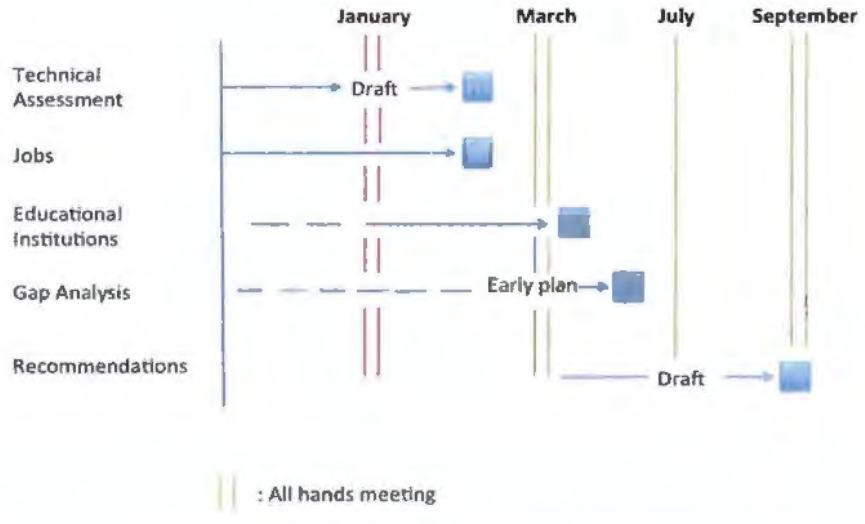
Project Timeline



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Adoption Projection Updates

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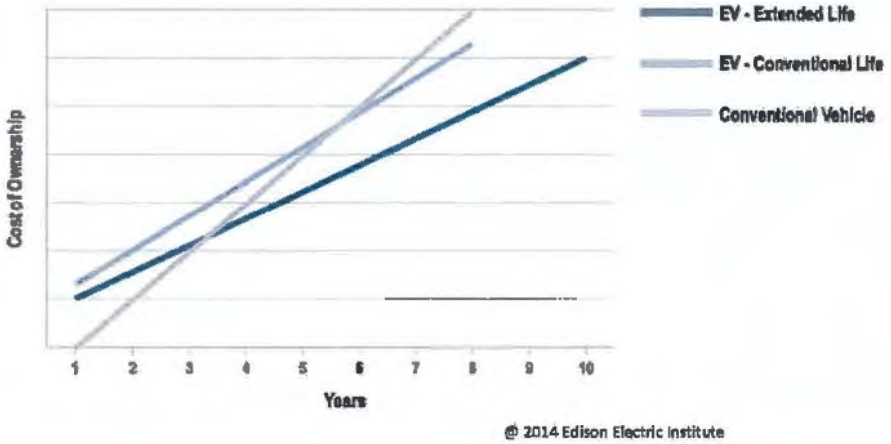
Fleet BEV TCO



LONG BEACH CITY COLLEGE

Yard Hauler Adoption

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
% Adoption		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
BEV Yard Hauler	9	0	32	40	40	48	55	63	79	95	103	111	127	801
HBEV Yard Hauler	5	0	1	1	1	2	2	2	3	3	4	4	5	34
Infrastructure (person years)	11	0	35	44	44	52	62	71	88	106	114	123	140	890
Vendor (person years)	6	0	18	22	22	27	31	35	44	53	59	63	72	454

- Projected units and labor component of install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in BEV to support new vehicles

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eRTG Adoption

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
% Adoption		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
eRTG	9	0	2	3	3	4	4	5	6	7	8	9	10	71
Infrastructure (person years)	51	0	14	18	18	21	25	28	35	42	46	49	57	405
Vendor (person years)	13	0	3	4	4	5	6	7	9	10	11	12	14	99

- Projected units and labor for install and manufacture
- Maintenance will have up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in BEV to support new vehicles

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Class 8 Truck Adoption

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
% Adoption		0%	4%	5%	5%	6%	7%	8%	10%	12%	13%	14%	16%	100%
Class 8 Trucks	4	0	9	11	11	13	15	17	22	26	28	30	35	71
Infrastructure (person years)	4	0	10	12	12	14	17	19	24	29	31	33	38	242
Vendor (person years)	2	0	5	6	6	7	8	10	12	15	16	17	19	123

- Only includes TTSI fleet
- Projected units and labor for install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in BEV to support new vehicles

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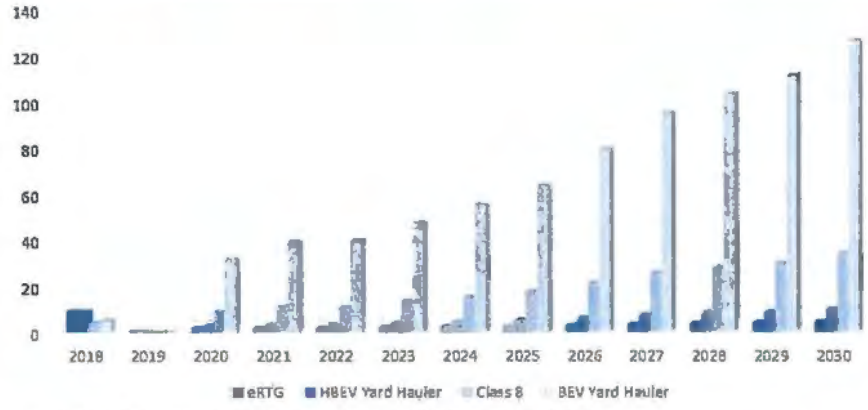
Equipment Projections



- POLB data used for infrastructure to vehicle total population
- HBEV likely interim solution towards ZEV
- Fuel Cell may emerge but this study focuses on pilot equipment
- Adoption curve slow at start, builds to meet 2030 target

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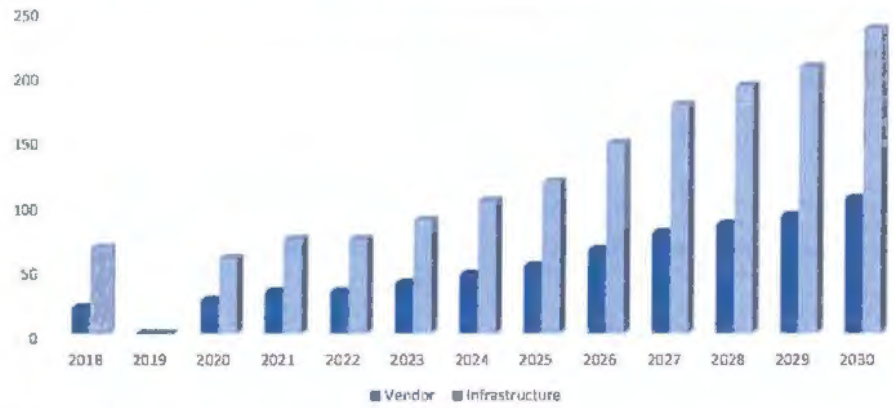
New Jobs Projections



- POLB data used for infrastructure to vehicle ratio
- Maintenance hours decrease, retraining useful
- Infrastructure jobs driven by adoption, largest gains
- Vendors are local, so additional jobs for production counted

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Report Outline

Draft Report Outline

Need Feedback

Please See Handout

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Training Resources

- Nine Colleges with both electrical and automotive programs
  - Cerritos, El Camino, Fullerton, LA Trade Tech, LBCC, Pasadena, Saddleback, Santa Ana, and Rio Hondo
- Four Colleges with Alternative Fuel Programs
  - LA Trade Tech, LBCC, Rio Hondo, and Saddleback College, (Rio Hondo has an AS degree in Alt Fuels)
- 15 Colleges with some related training program

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Skills Analysis

Draft Skills Analysis

Need Feedback

Please See Handout

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Next Steps

1. Update materials based on feedback
2. Create and deploy survey tool for Colleges in April and May
3. Outreach to local high schools
4. Present findings to group in late summer (in person meeting)
5. Finalize and present draft report to group in fall (in person meeting)

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JUNE 7, 2018

POWERPOINT PRESENTATION TO THE CEC AND CALIFORNIA PORTS

LONG BEACH CITY COLLEGE

Zero-Emission Port Equipment Workforce Assessment

By Melissa Infusino

Director, Workforce Development

www.lbcc.edu

LONG BEACH CITY COLLEGE

CEC Grant Background

- Demonstration project of Zero Emission Cargo-handling Equipment
- Vendors Cavotec, BYD, and US Hybrid will design and manufacture 25 new or converted electrified cargo handling vehicles for terminal operators ITS, LBCT, and SSA Marine as well as TTSI

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LBCC Scope of Work

- ZEV adoption projections
- Identify workforce needs to produce, operate and maintain electrification equipment
- Identify gaps in workforce skills and education and training programs to address these gaps

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LONG BEACH CITY COLLEGE

Team

- Long Beach City College
  - Melissa Infusino, Workforce Development Director
  - Dana Friez, Workforce Development Training Manager
- Advanced Sustainability Institute
  - Michael Boehm, Managing Director
  - Jennifer Bredell, Project Manager

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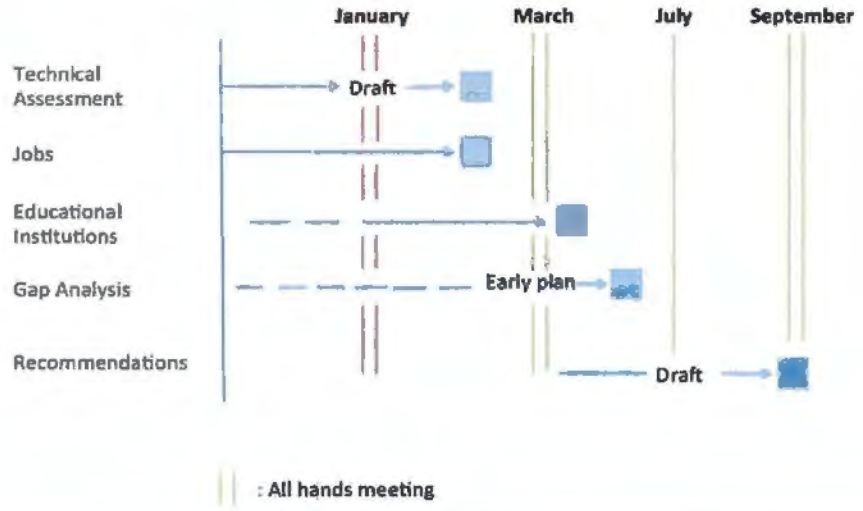
Project Timeline



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Interviews

ZEV Adoption Projections and Workforce Analysis

- Vendors Cavotec, BYD and US Hybrid
- Terminal operators ITS, LBCT, and SSA Marine as well as TTSI
- IBEW Electrical Workers Union
- LBCC Faculty
- Port of Long Beach Representatives
- Industry Experts

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Competencies
Employee or Student Competencies
New Areas of Skills or Learning
Job Category or Activity
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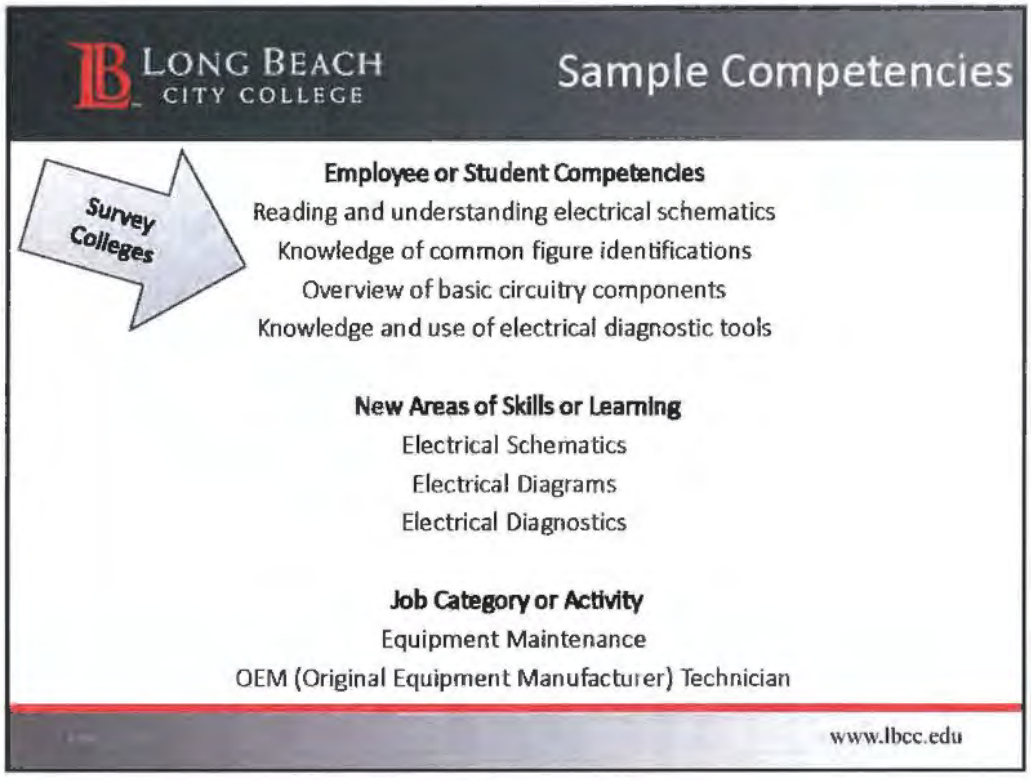
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Sample Competencies
Survey Colleges
Employee or Student Competencies
Reading and understanding electrical schematics
Knowledge of common figure identifications
Overview of basic circuitry components
Knowledge and use of electrical diagnostic tools
New Areas of Skills or Learning
Electrical Schematics
Electrical Diagrams
Electrical Diagnostics
Job Category or Activity
Equipment Maintenance
OEM (Original Equipment Manufacturer) Technician
www.lbcc.edu

Sample Competencies

LONG BEACH CITY COLLEGE

Survey Colleges

Employee or Student Competencies
General overview of basic principles of batteries
Knowledge of basic battery operation
Understanding of the different types of batteries
Electrical characteristics of various battery types

New Areas of Skills or Learning
Battery Theory

Job Category or Activity
OEM Technician

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Training Resources

LONG BEACH CITY COLLEGE

- Colleges with both **electrical and automotive** programs
  - Cerritos, El Camino, Fullerton, LA Trade Tech, LBCC, Pasadena, Saddleback, Santa Ana, and Rio Hondo
- Colleges with **alternative fuel** programs
  - LA Trade Tech, LBCC, Rio Hondo, and Saddleback College
- Local **Union** Apprenticeship and Training Centers
- Employment Training Panel (**ETP**) funded incumbent worker training

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LONG BEACH CITY COLLEGE

Next Steps

1. Survey Training Partners (Colleges)
   - Calls to faculty and department heads completed
2. Identify and survey surrounding high schools with related programs
3. Present draft report to Port in July
   - ZEV Technology Adoption Projections
   - Workforce Skills Gaps Predictions
   - Recommendations to Address Future Workforce Needs
4. Stakeholder meeting in September to present findings and recommendations

LONG BEACH CITY COLLEGE

Questions

Melissa Infusino
Director, Workforce Development
562-938-3217
minfusino@lbcc.edu

NOVEMBER 1, 2018

POWERPOINT TO LONG BEACH UNIFIED SCHOOL DISTRICT EDUCATORS

Skills for a Zero-Emissions Future

The Port of Long Beach and Long Beach City College

Presented to Long Beach Unified
November 1, 2018

Presenters

Morgan Caswell

Port of Long Beach

Environmental Specialist Associate

Morgan.Caswell@polb.com

Melissa Infusino

Long Beach City College

Director Workforce Development

Minfusino@lbcc.edu

Overview

Background

The Port of Long Beach recently updated their Clean Air Action Plan

The plan established a major goal to transition to zero emissions terminal equipment by 2030

Partnership

The Port of Long Beach is piloting new technology to achieve **zero-emissions**

Long Beach City College was invited to report on the impact technology would have on the **workforce**

CA Energy Commission Award

Alternative and Renewable Fuel and Vehicle Technology Program

Demonstration of Zero Emission Cargo-handling Equipment at Port of Long Beach

- 25 new and converted electrified cargo handling vehicles for use by terminal operators

Workforce skills and training gap analysis

Partners

- California Energy Commission
- Port of Long Beach
- Long Beach City College
- Vendors: Cavotec, BYD and US Hybrid
- Terminal Operators: ITS, LBCT, and SSA Marine as well as TTSI
- IBEW Electrical Workers Union
- Long Beach Unified School District

LBCC Role

Projections	Inventory	Final Report
Technology adoption projections -	Training Inventory -	Final Report -
Interviews with stakeholders	Identify and survey colleges	Adoption Projections Gap analysis
Original research	And high schools	Training Recommendations

Analysis and Inventory

Electrical Certificates and or Degrees

East LA College
LA Pierce College
LA Trade Tech
Long Beach City College
Rio Hondo College

Advanced Transportation Certificates and or Degrees

Cerritos College
Citrus College
Cypress College
East LA College
El Camino College
Fullerton College
Goldenwest College
LA Pierce College
LA Trade Tech
Long Beach City College
Pasadena College
Rio Hondo College
Saddleback College
Santa Ana College
Santa Monica College

Desired Areas of Competency

- Battery Safety
- Battery Theory
- Charging Components
- Electrical Connections in Corrosive Environments
- Equipment Maintenance
- General Electrical
- Mechanical Aptitude
- Zero Emission Technology

New Partnerships

California Energy Commission award funding new microgrid project

- LBCC to provide workforce impact analysis

Maritime Center of Excellence

- Short term not for credit workforce training in supply chain and logistics
- Boot Camp for High School Students
- Articulation with Unified School District and State University

NOVEMBER 7, 2018

POWERPOINT PRESENTATION TO THE ACADEMY OF GLOBAL LOGISTICS

LONG BEACH CITY COLLEGE

Zero Emission Port Equipment Workforce Assessment

Dana Friez

Workforce Development Training Manager

November 6, 2018

www.lbcc.edu

LONG BEACH CITY COLLEGE

The Partnership

- Port of Long Beach
  - Pursuing a shift to Zero Emission technology and standards within the Port
- Long Beach City College
  - Assessing workforce needs due to the coming shift in technology

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LONG BEACH CITY COLLEGE

Project Background

- California Energy Commission Grant for demonstration project of Zero Emission Cargo-handling Equipment
- Vendors Cavotec, BYD, and US Hybrid will design and manufacture a total of 25 new or converted electrified cargo handling vehicles for the terminal operators ITS, LBCT, and SSA Marine as well as TTSI

LONG BEACH CITY COLLEGE

LBCC Scope of Work

- **Quantify electrification progress** and predict ramp up numbers for the pilot, 3 year, 5 year, and 12 year intervals
- **Identify workforce needs** to produce, operate and maintain electrification equipment
- **Identify gaps in workforce skills** and education and training programs to address these gaps

LONG BEACH CITY COLLEGE

Approach to Work

- Research
  - Reports from various sources, e.g. Ports of Los Angeles and Long Beach, Fleet Manager, EPRI etc.
- Interviews
  - Interviews with terminal operators, technology vendors, Port, unions
- Projections
  - Electric powered equipment units adopted
  - Jobs and needed skills to support electrification

LONG BEACH CITY COLLEGE

Port Comparison

- Perform Port Comparison Research
  - Determine if there are other ports where major electrification efforts have occurred similar to what Port of Long Beach is doing
  - What ports are going electric?

LONG BEACH CITY COLLEGE

Port Comparison

Port of Busan

- "Busan North Port" has converted most of their equipment to electric
- 4 ports in total are fully equipped modern ports with automation
- Limited scope of project

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Port of Rotterdam

- Maasvlakte 2 Terminal at Port of Rotterdam is fully electric with power generated by wind turbines
- Additional two terminals are operated by automated equipment
- Emphasis on sustainability, such as renewable energy and energy recycling programs
- Limited scope of project

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Interviews

- Conduct Informational Interviews
  - Vendors, Terminal Operators, IBEW, LBCC Faculty, Port of Long Beach Representatives, Industry Experts
  - We asked about: Equipment adoption, workforce changes anticipated, current skills, anticipated future skills, challenges, etc.

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Equipment Adoption

- Develop Adoption Rate Projections
  - How quickly will ZEV equipment be adopted at the Port of Long Beach, and at what rate.
  - Adoption rate impacts changes needed in the workforce
  - Multiple types of vehicles, phased rollout

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Yard Tractor Adoption

Year		18	19	20	21	22	23	24	25	26	27	28	30	Total
% Adoption		4%	4%	5%	5%	6%	6%	8%	8%	10%	10%	12%	15%	100%
BEV Yard Hauler	9	32	32	40	40	48	55	63	71	87	95	111	119	801
HBEV Yard Hauler	5	1	1	1	1	2	2	2	3	3	3	4	4	34
Infrastructure	51	14	14	18	18	21	25	28	32	39	42	49	53	53
Vendor	13	3	3	4	4	5	6	7	8	9	10	12	13	13

- Projected units and labor component of install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in Electric Power technology to support new vehicles

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eRTG Adoption

Year		19	19	20	21	21	23	24	25	26	27	28	29	Total
% Adoption		2%	3%	4%	4%	6%	6%	8%	8%	10%	10%	12%	15%	100%
eRTG	2	1	2	3	3	4	4	6	6	7	7	9	11	71
Infrastructure	10	20	10	41	41	50	50	66	66	83	83	99	124	124
Vendor	5	15	15	21	21	25	25	34	34	42	42	50	63	63

- Projected units and labor component of install and manufacture
- Maintenance will see up to 50% decrease in labor hours compared to diesel
- Maintenance will need training in BEV to support new vehicles

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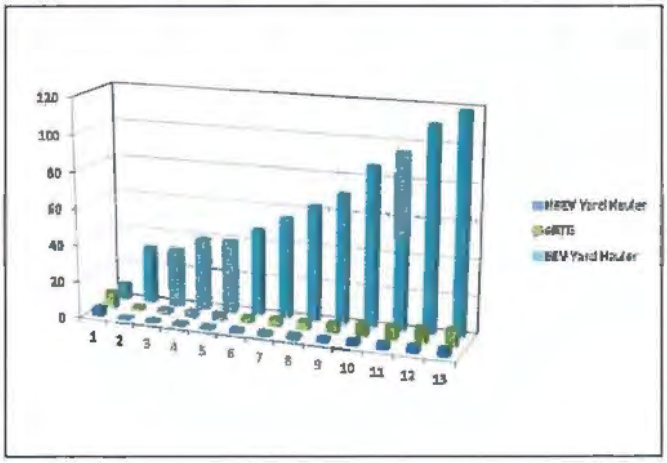
Equipment Projections

- POLB data used for infrastructure/vehicle total population
- HBEV likely interim solution towards ZEV
- Fuel Cell may emerge but this study focuses on pilot equipment
- Adoption curve slow at start, builds to meet 2030 target
- Year 1 = pilot, 2017 - Year 13 = 2030



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Next Steps

- A large portion of LBCC's work involves:
  - Workforce Needs Assessment
  - Skills Gap Analysis
  - What are these activities?

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Needs Assessment

- Gathering information on what current workforce needs are, and what future (anticipated) workforce needs will be. Can be:
  - Regional
  - Local
  - By Industry
  - By Company
  - By Job

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Skills Gap Analysis

- Determining skills needed, and comparing them to actual skills present. Can be:
  - By Job Category
  - By Job Classification
  - By Individual

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Job Projections

- Perform Job Projection Analysis
  - Which job classifications will be impacted by ZEV adoption
  - Are there job classifications needed that we don't have? Will the focus of these jobs need to change with the technology? Will there be jobs created?
  - Increase in new jobs anticipated
  - Skills updates needed for some

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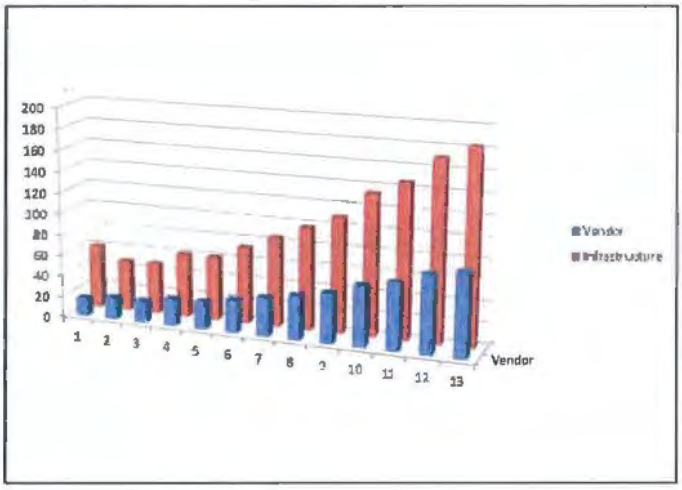
New Job Projections

- POLB data used for infrastructure/vehicle ratio
- Maintenance hours decrease, retraining useful
- Infrastructure jobs driven by adoption, largest gains
- Vendors are local, so additional jobs for production counted
- Year 1 = pilot, 2017 - Year 13 = 2030



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Skills Needed

- Identify what skills are needed
- Vendor Jobs:
  - Technicians with skills especially in electronics
  - Battery theory and safety
  - Schematic reading
  - Basic automotive repair skills
- Infrastructure Jobs:
  - High voltage safety (existing work force has this skill)
  - Battery and charging station training
  - Electrical systems in corrosive environment

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Jobs and Skills

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- Organize Job and Skill Information
  - Bring information together for easier review and understanding

Job Category or Activity	New Areas of Skills or Learning	Sample Employee or Student Competencies
Equipment Maintenance	Removing and Installing Electrical Components	•Understanding component diagnostics •Safely removing non-functioning components •Safely installing new or repaired components

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Educational Survey

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- Gather Information on Current Education and Training Programs
  - K-12 (that's you!), and community college programs; other providers, such as Union Apprenticeships, and Union training centers
  - **What community colleges has relevant programs?** What do they teach? What departments are they in?
  - Surveys, reviews of web sites/catalogs, interviews

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Gap Analysis

- Identify Where the Gaps Are
  - For Current Workers: What skills do they currently have vs what will be needed with new technology adoption
    - Will use this information to make training recommendations later on
  - For Future Workers: What competencies are being taught and do they align with what will be needed based on new technology
    - Will use this information to recommend changes to educational programs/schools

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The Report

- Bring it All Together
  - A written report to go to all stakeholders
    - Stakeholders each have different perspectives
    - Report must appeal to all and be relevant to all
  - Synthesize information gathered from interviews, surveys, and research; make recommendations based on gap analysis.
    - Recommendations made for current and future workers

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Review

- Let's Sum it Up
  - Electrification efforts at the Port will impact the skills that current workers need, and change how new workers should be prepared
  - We can identify and prepare for those changes by performing a workforce assessment
  - Research and interviews with stakeholders are how we gather this information to make projections and recommendations

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Questions?

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